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METHODS AND RESULTS

REPORT ON THE OYSTER BEDS

OF THE

JAMES RIVER, VA.

AND OF

TANGIER AND POCOMOKE SOUNDS

MARYLAND AND VIRGINIA

APPENDIX No. 11—REPORT FOR 1881

WASHINGTON

GOVERNMENT PRINTING OFFICE

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ERRATA TO APPENDIX No. 11—COAST AND GEODETIC SURVEY REPORT FOR 1881.

Page 7, line 43 from top, for "Moelius" read "Möbius."
Page 14, line 8 from top, for "up" read "rip."
Page 24, line 34 from top, for "Fog" read "Fox."
Page 27, line 44 from top, for "600,000" read "630,000."
Page 34, line 23 from top, for "light" read "bight."
Page 46, line 7 from top, for "welks" read "whelks."
Page 46, line 10 from top, for "welks" read "whelks."
Page 64, line 3 from top, for "successive" read "successful."
Page 65, line 2 from top, for "in" read "the."
Page 70, line 28 from top, for "welks" read "whelks."
Page 70, line 28 from top, for "*cinereus*" read "*cinerea*."
Page 70, line 36 from top, for "*cinereus*" read "*cinerea*."
Page 70, line 37 from top, for "welk" read "whelk."
Page 70, line 38 from top, for "welk" read "whelk."
Page 70, line 40 from top, for "welks" read "whelks."
Page 79, Appendix A, area Clump Point, for "382,000" read "382,500."
Page 79, Appendix A, area Horsey's Bar, for "202,000" read "202,500."
Page 79, Appendix A, area of Cow and Calf, for "292,000" read "292,500."
Page 79, Appendix A, area Cedar, for "337,000" read "337,500."
Pages 86 and 87, Appendix E, for "Monroe" read "Munroe," and for "analysis" read "analyses" wherever occurring.
Page 86, Appendix E, line 6, for "furnishes" read "furnish."
Page 86, Appendix E, insert at head of table "parts in 1,000,000 of water."

(APPENDIX No. 11, COAST AND GEODETIC SURVEY REPORT FOR 1881.)

REPORT ON THE OYSTER BEDS OF THE JAMES RIVER, VIRGINIA, AND OF TANGIER AND POCOMOKE SOUNDS, MARYLAND AND VIRGINIA.

By FRANCIS WINSLOW, Master U. S. Navy, Assistant Coast and Geodetic Survey, Commanding Schooner Palinurus.

PREFACE.

In editing the following reports, it has been my endeavor, while preserving the original form and design, to omit such matters as would be of no interest to the public, but which were properly communicated to the Superintendent of the Survey. Of such a character I have considered the history of the work, in so much as it related to the difficulties encountered in its prosecution, and the various recommendations as to special matters connected with future operations. I have also considered that the same minuteness of description, either of methods or results, which was manifestly proper in a report to my superior, would be unnecessary in a paper intended for general circulation. I have, therefore, in some parts, condensed the reports considerably, though always with care that the reader should experience no difficulty in following the steps by which I reached any conclusion.

In the manuscript reports and in letters to the late Superintendent, I have frequently testified to the kindness and assistance rendered me by the inhabitants of Crisfield, Md., and of the shores of the sounds, and I wish to again express, in a more public manner, my appreciation of their efforts, and especially my indebtedness to Mr. T. S. Hodson, the collector of the port. My thanks are also due to the members of the Johns Hopkins Zoological School, to Prof. S. F. Baird, United States Fish Commissioner, to Mr. T. B. Ferguson, Maryland Fish Commissioner, to Mr. H. J. Rice, and Mr. W. H. Dall, and especially to Dr. W. K. Brooks for assistance rendered me.

As such success as has attended my labors in this field is largely due to the zealous and efficient co-operation of my brother officers and companions on board the Palinurus, I have felt it their due that their contributions to the results should be known. I have accordingly prefixed to each report the names of my assistants and have specified those portions of the work for which they are in a measure responsible.

I regret that it is not in my power to more adequately express my appreciation of the zeal and energy they displayed, the arduous nature of their labors in the field, and the good judgment they showed in the compilations assigned them in the office, and while it is difficult to make a distinction, I feel my indebtedness to Master H. H. Barroll, U. S. N., to be greater than to any other one connected with the investigation.

FRANCIS WINSLOW,
Lieutenant, U. S. N.

INSTRUCTIONS.

The instructions of the Superintendent, dated August 2, 1878, directed that the investigation of the oyster beds should include the following:

1. The determination of the positions and areas of the oyster beds of the Chesapeake and its adjacent waters and the depth of water over them both at high and low water.

2. The determination of the character of the beds; whether natural or artificial; whether the

oysters were spread all over a given area, or grew in clusters of large or small size, or were scattered singly or in small groups.

3. The determination of the temperatures of the surface and bottom water at each locality and the velocities of the currents.

4. The preservation of specimens of oysters of different ages, from each locality, and specimens of the bottom and bottom water.

5. The determination of the existence of any deposit of mud or other earthy or vegetable material and the determination of the character of the bottom beneath the oyster beds.

6. The determination of the source of the sediment if any was deposited and the means of directing it, if injurious, away from the beds. Also to determine whether ice ever rested on the beds and so destroyed them.

7. The determination of the density of the water, with special reference to the question of displacement of the salt water by the fresh water from adjacent streams and rivers.

The Superintendent also desired that the examination should, at first, be confined to a limited area and made exhaustive. Subsequently the investigation was to be extended as far as the means at the disposal of the Survey would permit.

The instructions were received on the 3d August, 1878. On the 7th of that month the vessel sailed from Baltimore, Md., to execute them, and the party remained actively in the field until the 15th October, when the season closed. As the investigation was novel in design and execution, and as the difficulties encountered by the party were mainly due to the absence of all experience and previous exertions in the same field, I have thought it best to preface the account of the results of our labors by a short description of the methods employed in making the several determinations required by my instructions.

METHOD OF CONDUCTING THE INVESTIGATION.

The examination of the different beds was carried on in the following manner:

1.—Delineation of the beds.

The services of an oysterman of experience, and who was well acquainted with the localities of the different beds, was first obtained; the vessel was then anchored in such a position as to enable her use as one of the points for angling upon, and her position carefully fixed by sextant angles upon all points recognizable upon the chart. At the same time angles were taken upon any object that might be useful subsequently in fixing positions, either of the boats or schooner. By carrying forward our own points in that manner it was possible to dispense with signals, the erection of which would have occasioned much delay and the sacrifice of time and labor, to procure an unnecessary degree of accuracy. The boats then ran traverse lines, more or less open, over the adjacent beds, the size of the interior angle and the length of the line depending upon the supposed size and character of the bed; our general method was to work with the tide and endeavor to cross the lines as we returned over the ground. The "oyster pilot" was sent in one boat and one of the ship's company, who was an old oysterman, was sent in the other. They were provided with poles, which were marked to feet, and continually probed and examined the bottom as the boat passed over the line. The depth of water and character of the bottom were recorded as in ordinary hydrographic surveys. The position of the boat was frequently ascertained by sextant angles, but as the "points" were not always well defined, two angles were not considered sufficient, and angles on all prominent objects were taken. Occasionally, when in proximity to the schooner, mast-head angles and bearings were used for ascertaining the position of the boat, and in a few cases the bearing and distance of some well-defined point of land was estimated.

At intervals the boat was anchored, her position fixed, and specimens of oysters, bottom, and water obtained, and the temperature of the air, and surface and bottom water, observed; the character of the substratum of the bottom was also noted, and the set and velocity of the current recorded. The observations for ascertaining the character of the bottom beneath the surface and those for temperature were more frequently made than the others, and the current was measured only at such points as would give a fair idea of the general set of the flood and ebb tides; but

whenever an oyster specimen was taken, all the observations, with the exception of those for strength and direction of current, were made. Only general instructions could be given as to the points on the beds where it was desirable to obtain specimens of any kind, or observations for temperature or character of bottom, and much was necessarily left to the discretion of the officer of the boat, not only with regard to those points but also as to the general delineation of the beds.

So far as it went the work was satisfactory, but there were three great drawbacks to the use of the boats, viz: The time and labor necessary to effect anything with them, the inability to use the pole with any accuracy in depths over three fathoms, and the failure of the pole to discover anything but the solid beds. We attempted to use with the boats a small and light dredge made especially for us, but found it impracticable, the largest boat, when under oars, fully manned, or when under sail in a stiff breeze, being unable to tow the dredge or even to move it; consequently the boats were useless for collecting any information, except over solid beds in less than three fathoms of water.

To define the limits of those beds lying in deeper water and of those not entirely solid, or where the oysters were scattered either in groups or singly, recourse was had to dredging with the schooner, using an ordinary oyster dredge of 36 inches width and with twelve teeth. This method was found to be so much more satisfactory in all respects, that all the boat work, whenever it was possible, was supplemented by dredging lines run by the schooner. Traverses were made as with the boats, and observations for ascertaining the character of the bottom, both of the surface and substrata, observations of temperature, and the selection of the various specimens, were carried on. The position of the vessel, however, was more frequently ascertained than had been customary in the boat work. The lowest possible rate of speed was maintained that was consistent with safe and ready manoeuvering (a matter of some difficulty), and the dredge put over at intervals varying from two to ten minutes, and depending upon the character and extent of the bed, depth of water, and ability of the crew to get the dredge in, it being at times necessary to heave the vessel to in order to recover it. The dredge was put over from the weather side, and, after having dragged a sufficient distance to insure its bringing up a specimen, should there be any oysters, was hauled in by hand. The presence of oysters on the bottom was readily detected by placing the hand on the dredging rope, the uneven, jumping motion of the dredge as it gathered the oysters and shells being distinctly perceptible. The dredge was usually on the bottom from thirty to forty-five seconds, which length of time was sufficient for our purpose and sometimes enough to fill the dredge, a catastrophe which was not desirable. Soundings were taken along the lines, and, with the character of the bottom, recorded.

The following form for keeping the record was used and found to be of great value:

RECORD.

[Date, September 5, 1878. Day-mark, S. Recorder, S. E. Stevens.]

Time.	Depth.	Station.	Bottom.	Dredge.	Amount in dredge.	Ground log.	Right object.	Left object.
h. m. sec.								
7 10 20	15 feet.	3	Hard....	Over....	½ full.....	34 fms.	Clay Island Light-House.....	Red trees.
30	.....	.....	.....	Taking	168	.....	Red trees	Tall trees.
11 00	.....	.....	.....	Off bot.	oysters.	.....	Tall trees	Solomon's Lump Light-House.

Angles.	Specimens.			Tide.	Temperatures.			Remarks on oysters.	General remarks.
	Oysters.	Bottom.	Water.		Air.	Surface.	Bottom.		
° ′					°	°	°		
52 08	3	1	1	½ flood.	59	68	68	Large, single	Probed: 2 feet oysters, then
68 23	.....	.....	.....	.....	.....	.....	.....	Young growth and clusters.....	hard. 100 sail dredging to
28 00	.....	.....	.....	.....	.....	.....	.....	Many young and drills; no sponge	southward. Wind, SW—3.

The number of oysters in the dredge, the portion of the dredge filled, the character of the oysters, whether old or young, single or in clusters, large or small, the character of the parasites attached to the shells, the amount of grass, seaweed, and sponge in the dredge, the estimated

number of young smaller than the marketable size, and other pertinent remarks, were noted after each haul. At intervals during the day the number of dredging vessels in sight was recorded for reference, and subsequently an attempt was made to collect data for the estimation of the number of oysters taken in a day by each sail. At each anchorage the current was measured.

From the results given by using the pole in the boats and the dredge in the schooner, the outlines of the beds have been traced on the chart, the lines defining their limits including nearly all stations when the number of oysters was greater than one-tenth to the square yard, and though in some portions of the beds, as shown on the charts, the number was less than one-tenth, yet other circumstances, such as the character of the bottom, the amount of shell brought up by the dredge, &c., have caused them to be included as part of the beds.

The limit of scattered oysters can only be considered as approximate, as the lines were drawn from information received from local oystermen and from such observations as we were enabled to make ourselves. As has been already stated, the boats were unable to ascertain the positions of any but the solid beds or large clusters, and the schooner not being able to work in less than 8 feet of water, our ability to determine the area covered by the scattered oysters was necessarily limited. As that area, and indeed that of the solid beds also, is variable, changing from year to year, the line inclosing the scattered oysters may be considered as accurate as it is necessary to have it.

TIDES.

The mean rise and fall of the tides in the sounds is so slight (amounting to 2.3 feet in Tangier and 2.4 feet in Pocomoke), and generally the depth of water over the beds so great, that it was not considered necessary to establish tide gauges except in one case; such tidal corrections as have been applied to the soundings have been obtained from the Coast Survey Tide Tables. A comparison of the rise and fall of the tides, as given by those tables, with that given by a tide-staff erected at Clay Island Light-House, showed that during the months of October and November the greatest difference was nine-tenths of a foot. Owing to the vernal and autumnal gales the most considerable departure from the usual height of the tidal water occurs at those seasons, and it is therefore probable that one foot will represent the maximum error of the Coast Survey Tide Tables, and $3\frac{1}{2}$ feet the maximum rise of the tide in either sound. Considering the great depth of water over the majority of the beds, it was concluded that the slight variation in those depths caused by the tides could have but little influence on the oysters, and consequently the correction of soundings except in depths less than three fathoms has been neglected.

SPECIMENS.

The oyster specimens, 754 in number, were selected from large quantities brought up by the dredge and tongs, the endeavor being to take three specimens of different ages from each locality. One specimen of an adult oyster of two years' growth or more, one of from one to two years' growth, and one less than a year old, were usually selected. Shells, either old or new, and especially those having a large number of young clinging to them, were also occasionally preserved, and though a few specimens of oysters that had been transplanted were secured in order to show the effect of change of water, bottom, and depth, yet no examination of the planted beds was undertaken. In the selection of specimens we attempted to reserve such as would indicate the effect of different natural conditions. At the close of the day's work the oyster specimens were washed in salt water, opened carefully with a sharp-pointed, thin-bladed knife, and the upper valve detached from the muscle, and then replaced. A small wooden peg was then placed between the bills of the shell, the valves tied tightly together with twine, and the oyster wrapped in cotton cloth of a very open texture. The whole was placed in alcohol. The wooden peg kept the shell open sufficiently to allow the alcohol access to the body of the animal, and the cloth wrapper prevented the destruction or loss of anything of interest which might be attached to the shell. Six parts of alcohol to four of water were used, and to each specimen was attached a wooden label showing from whence the oyster came.

BOTTOM AND WATER SPECIMENS.

The specimens of bottom were obtained from large amounts of sand, mud, and gravel, brought up by the dredge or tongs. When the bottom was hard, an ordinary bottom specimen cup screwed into a 25-pound lead was used, but over the solid beds, or where the bottom was of hard sand, it was very difficult to obtain anything, either with dredge, tongs, or lead.

The specimens of bottom water were secured by using the drop-water cylinders, which are fully described by Lieut. Frederick Collins, U. S. N., Assistant Coast and Geodetic Survey, in his report on the "Densities of the Waters of Chesapeake Bay and Tributaries," published by the Survey in the Report for 1877, Appendix No. 14. The cylinders worked as successfully as during the previous summer, and there can be no doubt that the water brought up by them was a specimen of that at the bottom. All the specimens were tested with a hydrometer, and the readings reduced to those at the standard temperature of 60° F.

SUBSTRATUM OF BOTTOM.

The character of the bottom beneath the surface was roughly ascertained by means of an iron probe, 5 feet in length, attached to a long wooden staff. The probe was thrust as far as possible into the bottom, and the composition and character of the substratum estimated, the different constituents, whether sand, shell, mud, clay, or gravel, being easily recognized. Owing to the velocity of the currents, the speed of the vessel, and the difficulty of handling a long staff, but few determinations of the character of the substratum were made when the depth of water was greater than 3 fathoms.

CURRENTS.

The currents were measured by a current meter, or by an ordinary chip log, though the latter was not used frequently. The position of the stations for measuring the current was left to the discretion of the officer of the boat, but a sufficient number have been occupied to show the set and strength of the main current, and the effect on them of the prevailing winds.

NUMBER OF OYSTERS TO THE SQUARE YARD.

The number of oysters to the square yard was found by using a ground log in connection with the dredge. From the information derived from experienced oystermen, and from our own examination of those beds that had been dredged, I was of the opinion that a dredge, when of considerable size, and dragged slowly, usually collected everything met by it in its course. Considering that, at the suggestion of Mr. Rice, I used a small ground log to measure the distance traveled by the dredge. As that instrument was exactly one yard in width, it was concluded that it swept approximately clean one square yard for every linear yard it passed over. The ground log consisted of a small lead, a few ounces in weight, attached to a light line 1,000 feet long; between the lead and line was a length of copper wire of 20 feet; the line was marked every 5 fathoms and kept in a tub or on a reel ready for use; the lead was conical in shape to prevent its catching on shell clusters. When the dredge was thrown over, the lead was dropped to the bottom and allowed to remain there, the line running out freely until the dredge was lifted off the bottom, when the line was stopped and the number of fathoms run off with the number of oysters in the dredge recorded. The dredge was not allowed to remain on the bottom long enough to be filled, consequently none of the oysters were lost from its inability to receive them.

Though the foregoing method was imperfect it was the best that could be devised under the circumstances, and a similar method was used by Moelius in ascertaining the number of oysters on the Schleswig-Holstein bed. From the very small number of oysters to the square yard, as shown by the method, from the small number of oysters it assigns to the beds, and from comparison of the latter number with the number known to have been taken off the beds during our stay in the sounds, it is evident that the "number to the square yard" given in the records of the work are useful for comparison only; for in almost all cases the number of oysters given to the square yard must be considered as far below the real number. For instance, the number of oysters on the beds in Tangier Sound, south of Jane's Island Light-House, was estimated from the data of the

record given by the dredge and log to be 7,994,692, while from other observations I am positive that at least 2,000,000 oysters were taken from those beds in six days at the commencement of the oyster season. Such could hardly have been the case had there been but 8,000,000 oysters on the beds, and consequently we must regard the "number of oysters to the square yard," as shown by the method used, only valuable as establishing an initial number and standard by which the increase or decrease of oysters on the beds may be ascertained, and by which one bed or locality can be compared with another. Alone, the results of the dredge and log are valueless.

TEMPERATURE OF THE WATER.

It was originally intended that the temperature of the bottom water should be obtained by means of thermometers attached to the "drop cylinders" used for obtaining the specimens of water from the bottom, and six of those cylinders were fitted at the office with mercurial thermometers, inclosed within the spindle upon which the cylinder moves, the bulb of the thermometer being a little above the center of the cylinder when closed on the lower disk, and the graduated stem being exposed above the top, thus allowing the temperature to be read within any limits that would probably occur.

Under the direction of the assistant in charge of the office, a series of experiments were made by Mr. H. W. Blair, in order to ascertain the correction to be applied to the thermometers when moved through strata of water of different temperatures, and from water of one temperature into the air at another. With tables of corrections derived from those experiments, and with care in using the apparatus, we hoped to arrive at results that would be very nearly correct, but I regret to say that upon the first occasion when the cylinders were tried the thermometers were shown to be useless.

The cylinder is closed upon the lower metal disk by means of a spiral brass spring, which also holds the cylinder down firmly, thus preventing the escape of the specimen. The spring acts with considerable force, and we found that invariably the shock of the closure of the cup was sufficient to break the mercurial column and prevent any reading of the thermometer. Attempts were made on board the vessel to remedy the evil by diminishing the strength of the spring, and by placing a rubber buffer on the lower disk, but we were unable to prevent leakage, and subsequently the same difficulty was experienced at the office.

Owing to the failure of the thermometers in the water cylinders, and the inability to obtain any apparatus, at so short a notice, in time to be available for the season's work, we were forced to use ordinary unprotected thermometers, furnished by the Coast Survey Office, with corrections established by experiments made previously and subsequently to the work of the party. The thermometers were fastened to a lead, lowered to the bottom, and kept there a sufficient time to acquire the temperature of the surrounding water. They were then hauled up as rapidly as possible and the temperature read; at the same time the temperatures of the air and surface water was noted.

Owing to the rapid change of reading when the thermometers were moved through strata of different temperature, the observations are only reliable when the temperatures of the air, surface, and bottom water were identical.

As the investigation extended over so short a period of time, and as the spawning season had closed before we arrived on the ground, the recorded temperatures are of little interest, and have been omitted in the following papers.

NAMES AND AREAS.

In naming and describing the beds I have used the local names given them by the oystermen. The term "rock" is with them synonymous with "bed," as they regard only the solid portions of the area covered by the oysters. In the following pages the term "rock" indicates the solid, or approximately solid, portions of the bed. Areas are given in feet and miles. When the latter unit is used it is the nautical mile of 6,080 feet, and not the statute mile.

REPORT OF THE INVESTIGATION CONDUCTED DURING THE SUMMER OF 1878.

My subordinates and assistants during the season were Master H. H. Barroll, U. S. N., and Mr. S. E. Stevens. Mr. Barroll tested the water specimens, 475 in number, and corrected the hydrometer readings for temperature; and compiled and arranged the record books and the various tables appended and referred to in the report. Mr. Stevens assisted in plotting the work, calculated the areas of the beds and of the bottom covered by scattered oysters, and developed the profiles of the bottom.

OYSTER BEDS OF THE JAMES RIVER, VIRGINIA.

The examination of these beds was a very hurried one, and the delineation must be regarded as merely approximate, being the result of a hasty reconnaissance. On that account no attempt has been made to produce a chart similar to that of Tangier and Pocomoke Sounds, but the outlines of the beds, as shown by a few traverses run by the boats and as indicated by the local oystermen, have been sketched in roughly.

According to such information as it was possible for us to obtain, the beds do not extend above Deep Water Light, with the exception of a few small ones that are seldom fished on the account of the inferiority of the animals. We had not time to determine ourselves whether the information was correct, but I presume it to be so.

Below Deep Water Light the beds of any consequence are twelve in number, and of a total area (approximate) of 10.4 square miles. Taking them in order from Deep Water Light to Hampton Roads they are the Mulberry Point Bed, Point of Shoals Bed, Jail Island Bed, Blunt Point Bed, White Shoal Bed, Thomas's Point Bed, Kettle Hole Bed, Brown Shoal Bed, Bally Smash Bed, Naseway Shoal Bed, Cruiser's Bed, and the Nansemond Ridge Bed. The beds are "natural," and the following remarks apply to all.

Currents.—Nineteen observations were made of the currents, and established that, over the Mulberry Point, Jail Island, and Point of Shoals Beds, the general set of the flood is NW., with a maximum velocity of 0.5 mile per hour, and the general set of the ebb SE., with a maximum velocity of 1.7 miles per hour. These velocities were measured after or during moderate to stiff NW. breezes and spring tides, which conditions would increase the velocity of the ebb current considerably; it is probable that that velocity does not exceed one knot per hour under ordinary circumstances. The set both on flood and ebb is directly across the bed, but the main body of water follows the deep channel to the southward, the ebb striking the shore in Burwell's Bay, and at times washing a good deal of it away.

Over the Blunt Point, White Shoal, Thomas's Point, Kettle Hole, and Brown's Shoal Beds the current sets NW. and SE., with a maximum velocity of 0.8 mile per hour on the flood. The ebb on the first quarter showed a velocity of 0.3 mile per hour, and probably the maximum velocity is but little over one knot per hour, as the great body of water passes to the southward of the beds.

On the southern side of the river, over the Bally Smash, Naseway Shoal, Nansemond Ridge, and Cruiser's Beds, the general set of the currents is NW. and SE., except where the very shoal spots are met, when the current becomes variable in direction though not diminished in force. When the shoal ledge lies in the general direction of the river the effect does not appear to be so great, but where the shoal extends across the main current it is deflected from its usual course, and forms strong counter currents and eddies. Thus over the Bally Smash Bed the ebb was found to set to the SE., with a maximum velocity of 1.1 miles; over the Naseway Shoal on one side of the shoal ridge the set of the ebb was SW., with a velocity of 0.4 mile per hour; while on the other side of the ridge an observation made at about the same time showed a set of 0.2 mile NE. When clear of the obstructing shoals the current sets to the northward and westward on the flood, and to the southward and eastward on the ebb, with an average velocity of 0.5 mile per hour.

Over the Nansemond Ridge beds and inside of them the flood sets in towards Ragged Creek, and the ebb probably in the opposite direction.

In order to determine whether the salt water over the beds in the river, and especially over the Mulberry Point, Point of Shoals, and Jail Island Beds was displaced by the fresh water of the spring ebbs, specimens of water were obtained at every two fathoms of depth, on a section across

the river just above Deep Water Light, at low water, spring tide. The density of the water at that point and time is shown in the following table:

Section across James River.

Location.	Station.	Depth.	Tide.	Specific gravity.	Remarks.
		Feet.			
Near Deep Water Light-House	A	Surface	Low water	1.0083	
	A	6	....do	1.0084	Bottom, soft mud.
	B	Surface	....do	1.0088	
	B	12	....do	1.0082	
	B	24	....do	1.0088	Bottom, soft mud.
	C	Surface	....do	1.0077	
	C	6	... do	1.0078	Bottom, soft mud.

Comparing the specific gravity of the water obtained in the sections with that of two stations below Deep Water Light, which was obtained at nearly high water, a difference of density of 0.0037 is shown—1.0000 representing distilled water. So slight a change of density can hardly have any material effect upon the oysters, and, except during long continued freshets, which occur sometimes during the spring, the animals in all probability do not suffer therefrom.

According to the oystermen, during the winter ice frequently grounds on the shoal spots on the Beds, but never remains there long, unless the weather is of unusual severity, the strength of the current and the variability of the climate being sufficient to remove the ice in a short space of time. As to the amount of damage done the oysters by the ice, opinions varied a good deal; the general impression was that, though the oysters were poorer in quality and flavor, the ice did not remain long enough to kill many of them. Only a few persons could be interrogated, and they were not very intelligent; but, in the absence of any opportunity to investigate the matter ourselves, their opinion is given.

All the beds in the James River are subject to the deposit of mud and vegetable matter brought down by the freshets that occur in the spring. The Mulberry Point, Point of Shoals, and Jail Island Beds, owing to their position, are particularly unfortunate in this respect. The set of the current being directly across these beds, they are the first to receive whatever is held by the water. From the character and appearance of the river, it is probable that a large amount of earthy matter is brought down by every ebb tide; but the velocity of the current is so great, and the shoal rises so abruptly between the Point of Shoals Light and Deep Water Light, forming a wall and barrier, that the principal part of the sediment seems to be carried into Burwell's Bay, where it has gradually covered and destroyed a large number of small beds. The spring freshets always cover the Mulberry Point, Point of Shoals, and Jail Island Beds, but not always for a sufficient time to very seriously damage the oysters, the current managing to sweep off the deposit in time to expose the cultch to the spat. Occasionally the damage is great; for instance, we were informed that during 1871 and 1872 there were a succession of heavy freshets, which destroyed the fishing for several years. In 1876, the mud having been washed away and the cultch exposed, a growth of young oysters was noticed in all the beds about and above Jail Island. In 1877 the oysters about Deep Water Light were good, and probably during the coming seasons (1878–'79), the catch on all the beds will be large, as at the time of our observations the oysters were numerous, with the young growth predominating. Apparently, then, it requires from three to five years for the beds to recover from the effects of heavy freshets, and as the oyster becomes marketable in about two years, from five to seven years must elapse from the date of the freshet before the beds can be profitably worked.

Happily, the other beds are affected to a much less extent, though about the shoals on the southern side of the river the oysters are gradually deteriorating, presumably from deposit of deleterious matter. The variability of the currents about these shoal places, and the fact that the depth of water about them is decreasing and the shoals increasing in size, appears to support the inference. On top of the Naseway Shoal, which is completely dry at low water, quantities of shells were found, and in its immediate neighborhood, especially to the northward and westward, the

oysters were of a very poor quality, having deteriorated much of late years. In addition to the deposit by the James River, the Nansemond Ridge and beds off Pig Point receive a portion of the sediment brought down by the Nansemond River, but, other causes not operating, that deposit would not be sufficient to seriously injure the beds. Below Jail Island, on the northern side of the river, the beds are not so much affected by the deposit, and the oysters found on them are of a better quality than those on the opposite side of the channel.

Without incurring an expense not justified by the end sought, there is no practicable means of protecting the beds from this evil. Natural efforts appear to have sufficiently protected them in the past, and, if they are guarded in other respects, the loss on account of the deposit of matter brought down by the current, which is but occasional, will not interfere, to any great extent, with the industry.

Mulberry Point Beds.—These beds comprise an area (approximate) of 3,656,000 square yards. They lie to the southward and westward of Mulberry Point, on the north side of the swash channel, and northeastern side of the main channel.

Point of Shoals and Jail Island Beds.—The Point of Shoals beds lie to the northward and eastward of the Point of Shoals Light, and comprise an area of 14,941,000 square yards, approximately. They are bounded on the southward-and-eastward, southward, and southward-and-westward, by the main channel, the one-fathom curve of which clearly defines the limit of the bed, except for a mile and a half to the southward of the light. The northern boundary follows nearly the edge of the swash channel, which separates this bed from the Jail Island Bed; the latter lies to the eastward of the swash and northward of the main channel, and has an area, approximately, of 5,730,000 square yards.

Both the Mulberry Point and Jail Island Beds extend inshore as far as the sands which are found about at the one-fathom curve. The hydrography of the accompanying chart of the river was executed in 1874, and since that time very slight changes of depth of water can have occurred. It may therefore be accepted as giving the correct depth at the time of our examination. It shows that over the Mulberry Point beds the depth of water is from 1 or 2 feet in some places to 24 in others; on the Point of Shoals beds the same irregular bottom exists, the depth being from 2 feet to 30; and on the Jail Island beds from 3 to 16 feet are found. The soundings are given for mean low-water, the plane of reference; the mean rise and fall of the tides is 2.6 feet, and the maximum rise and fall 3.4 feet. The spring tides, however, fall 0.4 feet below the plane of reference, and consequently all the beds are subject to the grounding of ice of more than 16 inches thickness. As, however, the shoalest parts of the beds are situated on the boundary lines, they afford a certain amount of protection to the interior portions, the ice piling along the borders instead of lying in heavy masses upon the entire bed.

On the shoalest parts of the beds the bottom was found to be a stratum of shells with a light covering of mud and a substratum of hard sand. On these shoal places the oysters and shells were most abundant. The oysters were not evenly distributed over the entire bed, but grew in detached patches and ridges on and in the vicinity of the shoals, with numerous narrow mud sloughs intersecting and separating them. The deep water was found over these sloughs, and, generally speaking, the shallower the water the larger the number of oysters and the thicker and more solid the bed, this being especially true about the boundaries, where the beds rise abruptly from the main channel, and where great difficulty was found in attempting to penetrate them with the probe, while in the interior portions and in deeper water the surface stratum was of shells and mud, with 6 feet or more of soft mud underneath.

On the Jail Island beds the bottom was of shells and light, yellow mud, the stratum being about 4 feet thick; below it the bottom was mud. From the appearance of the shells I judged that they had been covered for some time; and that, combined with the unusual thickness of the shell stratum, leads to the opinion that this bed was receiving a larger amount of the sediment brought down by the river than either the neighboring oyster areas.

The oysters on the three beds are of the class known among the dealers as "snaps." They are small and poor, single or in small clusters of two or three, and when not transplanted are used for canning. There was no sponge or grass attached to the shells, and but very few of the usual inhabitants of a bed other than the oysters appeared to be present. Young oysters, of about one

year's growth and under, predominated, and the proportion of young to mature oysters was greater on the shoal spots and ridges at the edge of the bed than elsewhere, owing, probably, to the fact that such portions of the bed being shoalest, hardest, and cleanest, they offered superior points for the attachment of the drifting spat.

The oysters from the Jail Island Bed were considered superior to any in the river for planting purposes, though no reason was assigned for the preference. The oysters from all these beds are generally transplanted before being sent to market. No oysters were found in the main channel, and in the swash channel only a few, and those widely separated.

Along the southwestern side of the river and main channel, in Burwell's Bay, and off Day's Point, are a few small beds, separated by large mud sloughs and many old "rocks" buried in the mud. The bottom is of red mud, with a substratum of mud or sand. The adjacent banks of the river are of red clay, and appear to be gradually washing away with the swift current of the river. The oysters found were older than those on the opposite beds on the Point of Shoals, but were of a poorer quality, and the beds are seldom worked on account of the scarcity and inferiority of the animals upon them.

Blunt Point Bed.—This bed consists of a number of small rocks of a few hundred yards area, with mud sloughs between them. The area of the bed is about 1,125,000 square yards, but as the bed does not rise abruptly from the channel, like those already described, thus allowing a ready and nearly correct definition of its outlines, the area given for it must not be considered as more than a rough approximation. In the case of the Point of Shoals and Mulberry Point Beds the channels and sounds defined the limit of the oyster areas. In the case of the Blunt Point Beds the oysters are scattered in decreasing numbers from the center of the bed to the shores and channels, and the accurate or even approximately accurate delineation of the area covered by them would have required far more time than was at our disposal.

The bed is subject to a deposit of mud from the James River, but to a less extent than those beds already described; it also receives some sediment from the Warrick River. The bottom was found to be mud and shells on the surface, with a substratum of mud, except about the shoal places, where the substratum is hard, probably of sand. The contour of the bottom is more regular than that of the other beds, the depth of water as shown by the chart being from 7 to 8 feet.

The oysters were more numerous about the shoals and were distributed in a manner similar to those on the beds previously noticed, being collected in groups and patches separated by mud sloughs. They grew singly and in small clusters with no sponges attached and are of poor quality.

Thomas Point, Kettle Hole, and White Shoal Beds.—These beds are similar in character to the Blunt Point beds. The shoal portions embraced by the one-fathom curve show the original formation of the bed in the past, and mark what may be termed the backbone of the bed in the present.

The areas (approximate) are Thomas Point, 949,000 square yards; Kettle Hole, 1,792,000 square yards; and White Shoal, 1,300,000 square yards. The bottom on the Kettle Hole and Thomas Point Beds was found to be of mud and shells on the surface, the substratum on the Kettle Hole being of shell and sand, and on the Thomas Point Bed of mud, except when near the shoal spots. On both beds no oysters were found on the shoals when the falling tide exposed them, but great quantities of broken shells were mixed with the sand; on all contiguous parts the oysters were very thick. Away from the sand shoals the beds commence to be broken up by mud sloughs, and the oysters are found in groups, the size and number of the groups being inversely proportional to the distance from the shoal. The Kettle Hole Bed is nearer solid and uniform than the others, the rocks being larger and closer together. The depth of water over the beds is shown by the chart, and the same general conditions with regard to it that were noticed on those beds already described exist on those now under consideration. The covering of mud over the animals was quite light, and the beds appear to receive less of the sediment in the river than those above or on the opposite side of the channel. The oysters were single and in small clusters. Those from the Thomas Point Bed were small and of an inferior quality; those from the Kettle Hole were larger, of good quality, and with a moderate amount of white and gray sponge clinging to them, and on both beds the proportion of young oysters of less than a year's growth to those mature was very large.

Bally Smash and Naseway Shoal Beds.—The Bally Smash Bed lies between Goodwin Point and

Fishing Point, and about one mile off the southern shore of the river. Its area is (approximately) 984,000 square yards. The Naseway Shoal Beds lie NE. of Fishing Point, about the Naseway Shoals, and comprise an area (approximate) of 2,988,000 square yards. Both of these beds appear to have been originally formed about the shoals, those parts of the latter that are uncovered at low water showing a mass of shells broken and mixed with sand, and in their proximity the oysters are in greater numbers than near the margin of the bed. The depth of water on the Bally Smash Bed is about 4 feet; on the Naseway Beds it is the same, except in the mud sloughs, where the depth is from 6 to 8 feet. The Bally Smash appears to be an unbroken "rock," the bottom consisting of shells and oysters with a light covering of mud. The oysters were small and of the inferior quality known as "snaps." The strong current setting past and about the bed should have the effect of cleaning it, but the shoal, being dry at certain stages of the tide, appears to offer a barrier to the current in such a way as to cause a growth of the shoal to the northward and westward, where we found the largest amount of mud.

The Naseway Shoal Bed consists of a number of detached "rocks" separated by mud sloughs, except in the vicinity of the shoal, where the oysters were found in the largest numbers, and where the bed is comparatively unbroken. The "rocks" appear to follow the general direction of the shoals, and are in ridges and groups, scattering and becoming smaller in size as the distance from the shoal increases. The oysters were single, of all ages, and generally of poor quality, but inshore from the bed, where a number of small detached "rocks" known as mud and sand rocks are found, the oysters were larger and older in appearance, and the young growth was missing. The bottom on the Naseway Shoal was a thin stratum of mud and shells on the surface, with a substratum of mud, very thick in the sloughs, and of hard sand and shell in the vicinity of the shoals. The Naseway Shoal Bed is supposed to receive a larger amount of the sediment brought down by the ebb-tide than any other bed on the southern side of the river. As will be seen by the chart, the Eastern Shoal runs across the direction of the current, and the water deepens quickly to the eastward of the shoal. The "rocks" lie closer to the shoal on the eastern side than on the western, while the mud sloughs are more frequent on the western side than on the eastern. From the above it would appear that the western part of the bed received the larger amount of deposit, and that deposit was injurious to the oysters.

Brown's Shoal Bed.—The rocks composing this bed lie to the northward and eastward of the Naseway Shoals on the northern side of the river, and are situated, as their names indicate, on and about Brown's Shoal. The approximate area of the bed is 1,828,000 square yards. The depth of water is from 3 to 18 feet, the average depth about 8 feet, and the deep water is found as on the other beds, over the mud sloughs. The bed follows the general direction of the shoal, and is not so extensively cut up as those previously described. The bottom was of shell with a little mud, resting on a substratum of shell or hard sand. The oysters were single, and in small clusters, and were not evenly distributed, being thicker on the edge of the channel, where also was found the largest number of young. The oysters brought up having but little mud on them, and the soundings and probe discovering but a light covering of mud, it is presumed that there is comparatively but little deposit on the bed. The principal part of the sediment brought down on this side of the river is probably received by the Thomas Point and Kettle Hole Beds, and as we were informed that ice seldom grounded on Brown's Shoal, it is perhaps protected by the beds from that soil also.

CRUISER'S ROCK AND NANSEMOND RIDGE.

Cruiser's Rock and the beds of the Nansemond Ridge are situated off Ragged Island, on the southern side of the channel, and about the shoals extending from Barrel Point. Their approximate area is 6,925,000 square yards. The beds are similar in character to those already described, being intersected by mud sloughs, and the oysters growing in groups and patches, but the mud sloughs are smaller and the area of the groups larger than on the other beds. The depth of water over the rocks is from 7 to 8 feet, and the surface stratum of the bottom consisted of shells and a small amount of mud. The substratum was, on the shoal parts of Cruiser's Rock, hard and of sand or shell; on the Nansemond Ridge of soft mud and shell for about 5 feet. The oysters found grew in small clusters or singly, and were of inferior quality. They were not found to the north-

ward and eastward of the beds in greater depths than 15 feet, but exist to the eastward, scattered either in small groups or singly, as far as the channel into the Nansemond River. Inshore from the main beds are a number of small rocks and groups of oysters. From the character of the bottom on the Nansemond Ridge, it is inferred that there is a deposit of sediment accumulating on those beds, and from which Cruiser's Rock is free. The fact is that the position of the Naseway Shoals is such that they protect the upper portion of the ridge (Cruiser's Rock), while nothing interferes with the lower and middle portions, and the current out of the Nansemond River supports the inference. In addition there is a strong tide up along the Nansemond Ridge which would probably cause a deposit of any matter held in suspension. I was informed that these last-named beds were less exposed to the grounding of ice and its subsequent piling than any in the river. Attached to the oysters taken from the Nansemond Ridge was a variety of sponge, red in color, that was subsequently found on the Craney Island flats, and in large quantities in Tangier and Pocomoke Sounds. It is not often found where there is much mud or sand on the bottom, or where the oysters are scattered singly, and its presence is a good indication of a solid "rock," though its absence is not conclusive as to the non-existence of the same.

Between the Nansemond River and the channel into the Elizabeth River, and along Craney Island flats, are numerous small beds of unimportant area. They extend from the one-fathom curve out to about 2½ fathoms, growing in ridges and groups with wide spaces of mud between them. The oysters found were single and larger than any in the James River. There was also more red and gray sponge clinging to them than had been noticed before. The bottom was generally of mud and shells on the surface with, in the vicinity of the Elizabeth River, a hard stratum of sand and shells underneath, and in the vicinity of the Nansemond a substratum of mud None of the beds are important and are only fished for the local market. The practice of depositing on the Craney Island flats the matter dredged out of the Elizabeth River and Norfolk Harbor is gradually destroying the beds inshore, and especially those near Craney Island.

THE FISHERY AND ITS EFFECTS.

The oysters are removed from the beds in the James River with the tongs alone, no dredging being permitted, and this may account to some extent for the beds being made up of patches and ridges of oysters. This formation is only advantageous in so much as it assists the rapidity of the current, and in all other respects it is an evil. Beds such as Cruiser's Rock, Nansemond Ridge, and Point of Shoals, where the oysters in places are too thick, would be much improved by using a light scrape or dredge instead of the tongs in the fishery. If used with moderation, the surface of the bed would be cleaned, its area extended, the animals would be more evenly distributed and allowed more room for development, and the spat, having a larger and cleaner amount of "cultch" exposed, would probably attach in greater numbers. As, however, without stringent laws, rigidly executed, it would be impossible to keep the dredging within proper limits, and as there is but little prospect of such a thing occurring it is perhaps better, on the whole, that dredging is prohibited. The mud surrounding the beds is of too soft a character to permit any great extension of the present area, and thus one of the principal advantages of using the dredge would be lost while all its evils would be retained. Even as it is, the fishery is carried to excess, and all the beds, especially those in the neighborhood of Hampton Roads, are deteriorating.

TANGIER AND POCOMOKE SOUNDS.

The charts showing the oyster beds and limits of oysters in these sounds have been constructed from the *data* collected during the progress of the work.

Only the natural beds are shown on them, and no attempt was made to carry the investigation beyond the sounds, except in the cases of the Manokin and Big Annemessex Rivers, where the beds were large enough to make their delineation and study advisable.

The beds have been named from the solid "rocks" which they surround, and are indicated on the charts by the darker shades. In many cases it was a matter of some difficulty to determine the outlines of the beds proper, on account of their peculiar formation. It would have given an erroneous impression to have considered either the solid unbroken portions as the beds, or to have

taken the entire area upon which oysters are found, and I have therefore adopted the number of 0.1 oysters to the square yard as the standard by which to determine the outlines, all positions where the number fell below that standard being excluded from the beds, unless other circumstances have led me to a different decision.

The light shades on the charts show the area occupied by scattered oysters, and, as already explained, must be considered only approximate. The broken lines show areas where the oysters are very widely separated. The dark lines have been drawn through those positions where the number of oysters to the square yard was above the average.

In designating the oysters, the term "young growth" has been applied to the small oysters that were evidently but one year or one and a half years old. The term "young" has been applied to small oysters of the last brood that were found clinging to the mature oysters and old shells, and were, on an average, about one-half or three quarters of an inch in length, or under.

Tangier Sound extends north and south, in round numbers, 36 miles, from Watts' Island to the head of Fishing Bay, and each side of the channel for 32 miles is lined with oyster beds of greater or less extent. These beds are continued, though the oysters are generally scattered, through Kedge's, Hooper's, and Holland Straits, and on the shoal between Smith's and Tangier Islands. On each side of the channels into the Nanticoke, Manokin, and Big Annemessex Rivers, beds are found, and to a less extent in the Wicomico and Little Annemessex Rivers.

By reference to the chart it will be seen that the only parts of the sound unoccupied by oysters are a short space, one mile in length, off Deil's Island, a space of two miles north of Jane's Island Light and between the Big and Little Annemessex Rivers, and a stretch of 2½ miles on the western side of the sound off Reach Hammock and the northern part of Tangier Island.

With these exceptions, the oysters are to all intents continuous, and the total area covered by them amounts to 69.12 square nautical miles.

The area of the beds proper, or that part of the total area on which the number of oysters to the square yard was at least 0.1, is 17.97 square nautical miles.

Whenever the names of the beds could be ascertained they have been given to them, but in some cases they could not be, and I have included them under general heads.

Taking them from the head of Fishing Bay in regular order, they are twenty-eight in number.

FISHING BAY BEDS.

Under this head I have included all the beds lying in Fishing Bay, north of Clay Island Light-House, as they are subjected to similar influences of current, bottom, water, and temperature, and present similar characteristics. Most of the beds are of small extent, and many have special names; but the printing of the latter would encumber the chart, and consequently they have been omitted. Almost the entire bay, as far as Fishing Point, may be considered an oyster bed, oysters existing, though very irregularly distributed in groups of greater or less extent, over the whole area, except in the channel and close inshore. The groups, or "rocks," are represented on the chart by the dark shades, and are forty-three in number, comprising a total area of 3,600,000 square yards. The remainder of the space, 25,605,000 square yards, is occupied by small groups and patches of oysters, separated by large mud areas.

The beds or "rocks" become smaller as the head of the bay is approached; they grow about any marked shoal, and all are somewhat broken by small mud sloughs, especially about the edges. The center of each "rock," and noticeably on those in the middle and wider part of the bay, are comparatively solid, and about such places the oysters were found in greater numbers than near the mud sloughs and channel. In the northern part of the bay the depth of water over the beds is from 4 to 10 feet; over the southern part from 8 to 12 feet; the general depth, except in the channel, is about 11 feet.

The bottom in the northern part of the bay is hard, of shell mixed with mud, the stratum being from 4 to 6 feet thick, over a stratum of sand on clay. The bottom surrounding the beds was of mud. Soft, sandy bottoms were found along the shores, especially about Fishing Point and about the mouths of creeks. On the western, northern, and northeastern shores, marked "Planting Grounds" on the chart, the bottom was of clay with a light covering of mud on the surface. On the southern beds the bottom is a stratum of oysters and shells mixed with mud, 1

to 3 feet in thickness, over a stratum of mud, except in the southwestern part and on a small rock on the eastern side of the channel, near Clay Island Light-House, where the substratum is of sand. The rocks are surrounded, like those to the northward, by soft muddy bottoms, except in the case of those in the southwestern part of the bay, where the surrounding bottom is of sand; those beds having sand as a substratum were less broken than the others. In the channel the bottom was invariably of soft, dark mud.

On the northern beds of the bay the oysters were single and of small size, with many of recent growth and probably about one year old. No sponges and but few of the usual molluscan inhabitants of an oyster bed were discovered. On the extreme northern beds above Fishing Point, where the water is shoal, the beds old and much worked, the oysters are scarce, but on the other beds a very fair number were found. They were round and thin shelled and gave promise of developing into those of good quality, but the majority were too young at the time of our observations to be removed from the beds.

On the southern beds the oysters were larger and of a better quality than those to the northward, though the young growth still predominated. Some clusters were found, but generally the oysters were single and more plentiful than in the northern part of the bay, but the same sparseness of the fauna was noticed. In the southern portions, where the bottom is sandy, a moderate number of young and many *astyris* were discovered, and in the same part of the bay many oysters were found buried in the sand 3 or 4 inches. I was not able to ascertain whether that was their normal condition or not, but am inclined to think the sand was moved over them by a gale which occurred during the day previous to our examination.

A remarkable absence of young of less than a year's growth, and nearly a total absence of the drill, seem peculiar to the Fishing Bay beds.

Were Point Bed.—South of the Fishing Bay beds and north of Hooper's Strait Channel lies the Were Point Bed, comprising an area of 1,845,000 square yards. It is divided about the middle by a narrow strip of sand and mud into two irregularly-shaped portions, the upper one of which is similar in character to the Fishing Bay beds, though more broken. On both portions the oysters grow in groups and patches, separated by mud and sand sloughs, the separation being more marked about the edges of the bed. Oysters are found over the entire surface, but are not evenly distributed, the largest number on the southern portion being found along its northern and eastern border. The depth of water is from 9 to 15 feet, the general depth being about 11 feet. The bottom is of oysters and shells mixed with sand and mud, for about 2 feet, with a substratum of soft sand or mud. Where the groups occur the shell stratum is very thick, but is thin over and about the mud and sand spaces. Along the dark line on the chart, indicating the largest number to the square yard, the bottom is harder than elsewhere. The muddy bottoms were found principally on the eastern and southern portions of the bed, and the bed is bounded in those directions by bottoms of a similar character, while to the westward the contiguous bottom is of sand. The oysters were single, of moderate size and fair quality; very few young and no drills were found, either on the muddy or sandy bottoms; there was no sponge or grass among the oysters, and young growth of at least one year predominated. The scattered oysters near the bed were similar to those on it, though a few small clusters were found to the westward.

The number of oysters to the square yard, as given by the mean of fourteen measurements, is 1.25. On account of the shoalness of the water and softness of the bottom, the number is more nearly correct than usual, but it must be remembered that in this, and in all other cases, where the number to the square yard is given, that number only expresses "marketable" oysters, and does not include those which would not be accepted by a dredger, or which on account of want of age are practically incapable of reproduction.

Shark's Fin Bed.—Directly south of the Were Point Bed on the western side of the main channel and south of Hooper's Strait Channel, lies a bed of moderate size, but celebrated for the quality of its oysters, called the Shark's Fin Rock. It is regular in shape, extending ESE. and WNW. about one mile, and being about one-half mile broad. Its area is about 1,867,000 square yards Practically, it joins the Were Point Bed at the southern extremity of the latter, the space separating the beds being very small. In the course of time through the action of natural causes and the dredges this space will be obliterated and the union of the beds made complete.

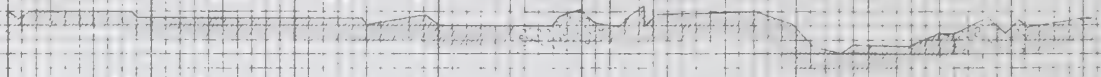
DIAGRAM I

PROFILES OF BOTTOM

Horizontal Scale 200 feet to one division

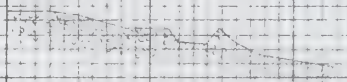
Vertical " " " "

PROFILE 1.



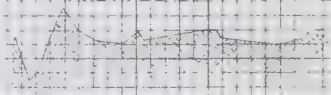
ACROSS FISHING BAY

PROFILE 2.



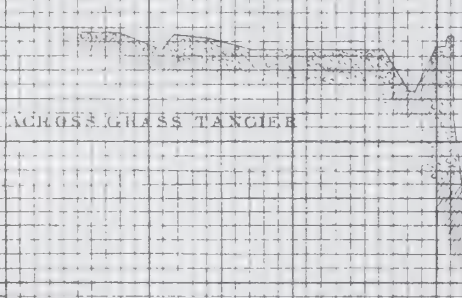
ACROSS SHARKS FIN BED

PROFILE 3.



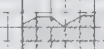
ACROSS NANTUCKET MIDDLE GROUND

PROFILE 4.



ACROSS GRASS TANCIER

NOTE



Represents Muddy or Sticky Bottom

" Sandy Bottom

" Rocky "

The Shark's Fin is a more compact bed than its neighbor, though about the edges, especially those bordering on the main channel, the oysters exist in groups, as on the beds already described. The animals are spread over the entire area, but are found in larger numbers about the central and more solid portions of the bed, and are scattered more and more widely as the borders are approached. The southern limit is not very well defined, scattered oysters extending farther in that direction than in the others. The depth of water is from 8 to 15 feet, the general depth being about 12 feet. The bottom is hard, consisting of oysters and shells with mud and sand for about 3 feet, and then a stratum of soft sand or mud. On the western part of the bed the shell stratum is much thinner and the substratum is hard sand. East of the bed the bottom, being that of the main channel, is of mud, and to the westward and southward of sand, soft near the bed, but growing harder as the distance from the bed increases.

The oysters were single, of a moderate size and fine quality. Very few young and no drills or other enemies were discovered, but the young growth of less than a year were found in large numbers, and also a little of the red sponge on the northern part of the bed. The scattered oysters were similar in character to those on the bed, though a larger proportion of young growth was found to the southward, and the same absence of "young" and drills was noticed both on muddy and sandy bottoms. On the bed the number of oysters to the square yard was 1.01. The number to the square yard on the area covered by scattered oysters west of the bed was 0.04, east 0.03, and south 0.03.

Nanticoke Middle Ground Bed.—On the middle ground between the channels into the Nanticoke and Wicomico Rivers there is a large bed of an area of 3,195,000 square yards, called the "Middle Ground Rock." It extends along the channel into the Nanticoke about 2¼ miles, and its greatest breadth is three-quarters of a mile. The bed is broken in many places, as will be seen on the chart, where only the larger divisions are shown, and the oysters grow in groups and patches of different areas with mud sloughs separating and intersecting them in all directions. The whole bed is broken up in this manner, but it is less noticeable on the northern and southern portions than on the central. The depth of water is from 8 to 21 feet, the deeper water being found along the western edge of the bed, where it borders on the channel, but, as the shoal rises abruptly, the parts of the bed covered by deep water are of small extent, and the general depth may be considered as about 11 feet. The bed is clearly defined by the channel of the Nanticoke on the west and the sands on the east. The bottom is a thin layer of mud over a stratum of shells and oysters from one-half foot to 5 feet in thickness. About the middle and western portions of the bed the substratum was soft mud, while on the northern, eastern, and southern portions hard sand was found underneath the shell stratum. The bottom on the central part of the bed in many places appeared to consist of alternate strata of shells and mud and on the northern and southern parts the general character of the bottom was much harder than on the central portion. To the northward and eastward of the bed the bottom was of hard sand or fine gravel, and probably the lowest stratum of the bed bottom, could it be reached, would be found of similar nature. South and west of the bed and in the channels the bottom is soft mud. Only a few oysters were found in the channel into the Wicomico, and none, in that into the Nanticoke.

The oysters were generally of an inferior quality and small size, and grew singly and in small clusters, though the number of the former was comparatively small. No young were found, but many young growth, probably about one year old, and no sponge, grass, or drills. Along the edge of the Nanticoke Channel the shells were blackened, probably by the mud. On the west side of the Nanticoke Channel, north and east of the one-fathom sand shoal, there are a few small beds, comprising a total area of 270,000 square yards. The depth of water over them is from 4 to 8 feet, and they are unbroken but separated from each other by spaces of mud or sand. Over these spaces the depth of water increases. The bottom is a stratum of shells, about one foot in thickness, over a stratum of sand and clay. A light covering of mud lies on top of the shells. The oysters were single, with many of a young growth. Many shells, but no young or drills, were found. West of these beds and southeast of Clay Island light the oysters are very thinly scattered, in small groups or singly. The three-fathom curve approximately defines their limit to the

southward and westward, and the one-fathom curve the northern limit. The bottom is of mud or sand, the latter being found inshore.

Clump Point Rocks.—These are small beds lying on each side of the channel into the Wicomico River and between Long and Clump Points. They are of small area, comprising collectively but 382,500 square yards, and lie in from 5 to 10 feet of water; they are separated from each other by the muddy bottoms of the channel or sloughs. All the rocks are broken in many places, the oyster groups separated by spaces of mud and sand, the latter species of bottom being found principally near Long Point. On the rocks the bottom is of shells and mud, with a substratum of mud. Very few oysters were found on the bottoms surrounding the rocks, and those discovered grew in small groups, the number and size of which decreased very much to the eastward of Long Point. The oysters were very scarce and resembled those of the Nanticoke Middle Ground in general character, though a larger number of single ones were found than on that bed.

Horsey's Bar and Tyler's Rock.—These are comparatively small beds, lying on the southern side of the Nanticoke Channel, southwest of the Middle Ground and north of Haine's Point. The first bed extends north and south three-eighths of a mile and east and west one-eighth of a mile. Its area is 202,500 square yards. The second bed lies southwest of Horsey's Bar, and is one-half mile in length and breadth, and comprises an area of 675,000 square yards. Both beds are unbroken, except about the edges, and on the major portion of each bed the oysters are evenly distributed. Along the northern and southern boundaries, where the beds border on the channels, the oysters are found in groups, separated by mud sloughs. The depth of water over Horsey's Bar is 12 feet, over Tyler's Rock from 14 to 16 feet. The bottom consists of a stratum of shells from 1 to 2 feet in thickness, on a stratum of hard sand; on top of the shells was a light layer of mud. The oysters were small, single, and of poor quality, and those of one year's growth predominated. No young, drills, sponges, or grass were found on the beds.

Drumming Shoal Bed.—This bed lies on and about the shoal off Haine's Point, from which it derives its name. It is one mile and three-quarters long and three-eighths of a mile wide, and extends in a northeasterly and southwesterly direction along the eastern edge of the main channel of the sound. Its area is 2,430,000 square yards. The bed is unbroken, the central and southern portions being remarkably hard and solid. About the edges, as with the other beds, it is intersected by mud sloughs, and the oysters grow in the usual groups and detached patches, but generally they are evenly distributed, a slight difference existing in favor of the shoaler and central part of the bed lying on the Drumming Shoal.

The depth of water is from 10 to 20 feet, the deeper water being found on the northern part and along the western border. The major portion of the bed has but 11 feet over it. On nearly the whole bed the bottom consists of a stratum of shells with a light covering of mud over a stratum of hard sand. On the extreme northern part the substratum was mud, and the surface stratum of shells not so thick as elsewhere. The oysters were single and in small clusters; a moderate number of shells and a little of the red sponge was found. Inside of Drumming Shoal is a small bed called Haine's Point Rock, which has been included in the description and area given for the Drumming Shoal Bed, with which it is closely connected.

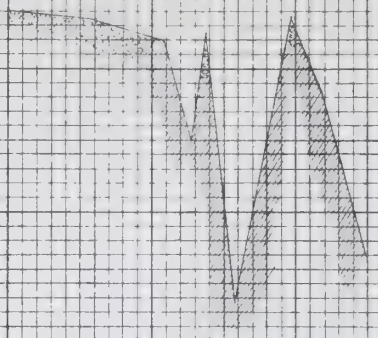
Cedar Rock.—This bed lies about one-half mile south of the Drumming Shoal and comprises an area of 337,500 square yards. The depth of water over it is from 12 to 17 feet and in all respects it is similar in character to the Drumming Shoal Bed.

On the western side of the sound, along the edge of the channel, the beds are nearly continuous from the Shark's Fin to the Terrapin Sands, a distance of about 11 miles. This space was originally divided into three portions, each locality having a particular designation, but at present it is difficult to define their limits, the spaces separating the beds having gradually diminished until they practically have ceased to exist. The dark lines on the chart indicate the positions where the largest numbers of oysters are found, and will show approximately the situation of the original unbroken "rock" from which the locality derives its name. The oysters taken from this region are known in the market as "Grass Tangiers" and have a good reputation, both for size and flavor.

The Cow and Calf Beds.—These are two small beds lying on the edge of the channel and south of the Shark's Fin. This area is 292,500 square yards. The smaller bed, called the Calf, has from

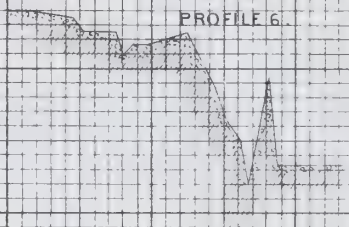
DIAGRAM Z.

PROFILE 5.



ACROSS MUD BED

PROFILE 6.

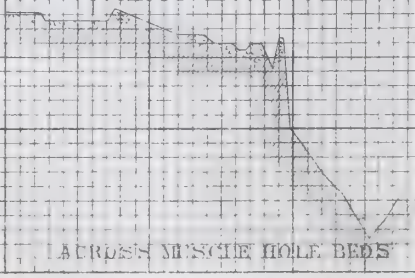


ACROSS MUD BED

PROFILE 7.

ACROSS MUSCLE HOLE BEDS

PROFILE 8.



ACROSS MUSCLE HOLE BEDS

9 to 16 feet of water over it; and the larger bed, the Cow, has from 9 to 11 feet. The beds consist of large groups of oysters separated by mud sloughs; the "rock" itself is a very hard and thick stratum of oysters and shells, into which we could not force the probe more than 2½ feet. The oysters were small, with about two-thirds of young growth; neither young nor drills were found. The number of oysters to the square yard was 1.51, which is probably more nearly correct than usual, the hauls of the dredge being made under exceptionally favorable circumstances.

On the western side of the channel and Sound and due east of the southern part of Bloodsworth Island is a large bed, the name of which we were unable to ascertain. It is two miles long, extends north and south, and is from two-eighths to five-eighths of a mile wide. Its area is 4,027,000 square yards. The eastern part of the bed is unbroken, but the western portion and the extreme eastern border are cut up by mud sloughs, which separate the oysters and leave them in groups of different sizes. Along the eastern part, almost immediately after striking the bed, we discovered a shoal ridge about 200 yards wide, which was unbroken and had a depth of water over it of 10 or 11 feet. To the westward of this ridge the water deepened quickly 3 or 4 feet, but the general depth of water over the bed is from 10 to 14 feet. The oysters are distributed over the entire area, but unevenly, the largest number being found on the central and southern portions of the bed. The bottom was found to be generally a stratum of shells, oysters, and mud, of about one foot in thickness, over a stratum of mud. Along the shoal ridge oysters and shells were found as far as the probe could penetrate. To the westward of the bed the bottom is soft sand or mud, the sand predominating and becoming harder as the shores of the island are approached. To the eastward the bottom is soft mud. The oysters were single and of moderate size. Large numbers of young growth, but neither young nor drills, were discovered. A little red sponge was found on the eastern edge of the bed. To the southward of the bed the oysters were larger, but not so many of recent growth were found, while to the westward the scattered oysters presented similar characteristics to those on the bed, and the same absence of young and drills was also noticed. The number of oysters to the square yard, the mean of ten observations, was 1.06.

Turtle Egg Island Bed.—This bed is situated on the western side of the channel, off the small island from which it derives its name. It is irregular in shape, extending along the edge of the channel in a NNE. and SSW. direction about 1¼ miles, and is from one-quarter to one-half mile broad. Its area is 1,620,000 square yards. The bed is unbroken about the center, but narrow mud sloughs intersect the northern, eastern, and southern portions; to the westward the oysters are scattered; on the eastern border of the bed they are more numerous than elsewhere. The depth of water over the bed is from 10 to 23 feet. A ridge similar to the one on the bed immediately to the southward was found along the eastern edge with a depth of water over it of about 12 feet; to the westward of the ridge 14 and 16 feet were found, and to the eastward much deeper water. The surface stratum of the bottom generally consisted of shells and oysters mixed with mud or sand; on the eastern portion of the bed the substratum was mud, while on the western and northern portions it was sand. East of the bed the bottom was soft mud; west of it soft sand on top of hard sand. The oysters were single, a few of large, but most of moderate size, of good quality, and many of recent growth. Neither young nor drills were found. A little red sponge was brought by the dredge on the SE. border, and a good deal of grass was found on the sands to the southward and westward of the bed. Very few oysters were found to the westward. East of the bed, on the small rock in deep water, many young growth, but no young, were discovered. The number of oysters to the square yard on the bed, as given by the mean of thirteen observations, was 0.38. On the small rock referred to above, the number to the square yard was 1.30.

Mud Rock.—This bed lies on the western side of the channel, south of the Turtle Egg Island Bed, and east of South Marsh Island. It extends north and south about 1½ miles, and is from one-quarter to one-half mile broad. Its area is 1,845,000 square yards. The bottom is very irregular, the depth of water being from 12 to 34 feet. The ridge along the edge of the channel was not as prominent as on the two beds previously described. The bed is broken in many places by mud sloughs, and about the eastern portion especially, where the oysters are in groups and patches. In the vicinity of the line showing where the largest number of oysters exist, the bed is more solid and the bottom harder than elsewhere. As this line crosses the bed three times, and from other circumstances, it is concluded that the distribution of the oysters is irregular, and the conclusion

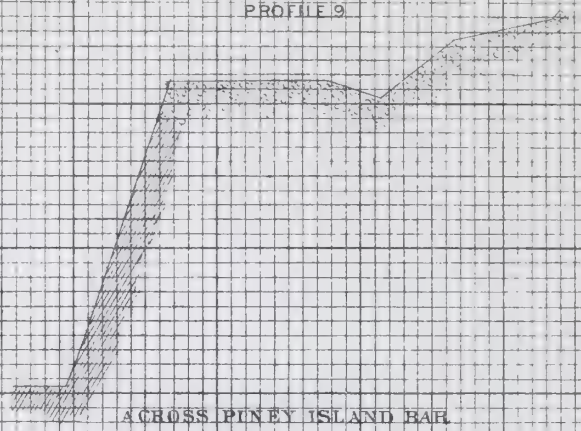
is supported by the evidence of the sounding pole and probe. East of the northern part of the bed, in the channel, are two small shoals with 12 feet of water on them. On and around them small oyster beds have formed, and between the shoals and the main bed oysters are found scattered in groups in water as deep as 8 fathoms. On the main bed the bottom is a thin stratum of oysters and shells resting on mud or sand. East of the bed soft blue mud was found, and to the westward mud, shells, and sand. The oysters were large, single, and in small clusters, and of good quality; the largest oysters were found on the soft muddy bottoms; the number of young growth was smaller than on the beds previously described, while the number of young was larger; a few drills were found about the edges of the bed and a moderate amount of red sponge. On the small beds in the channel the oysters were principally of recent growth. East of those beds a good deal of grass was found, and also in the deep water between the shoals and main bed.

Chain Shoal Bed.—This bed lies on the eastern side of the channel, abreast the Lower Thoroughfare and Little Island. It extends north and south 1½ miles, is from one-eighth to three-eighths of a mile wide, and comprises an area of 1,192,000 square yards. It is unbroken, except about its western border, where the oysters are found in groups; to the eastward the sands, on which are scattered a few single oysters, clearly define the limit of the bed in that direction. The bottom is irregular, the depth of water being from 12 to 19 feet, and the upper stratum consisted of shells, oysters, and mud; the substratum was of hard sand. The surface stratum was from 1 foot to 4 feet thick, and, with a diminished amount of sand, increased in thickness on the southern part of the bed. The surrounding bottoms are of sand, though on the western side the mud of the channel approaches the bed closely. The oysters were of moderate size and fair quality. The mature oysters were single; those of recent growth, a large number of which were found, were single and in clusters, the latter predominating. Very few young were discovered, and very few drills (*astyris*); the latter were located principally on the southern part of the bed. A large amount of red and gray sponge was found on all parts of the bed. The oysters on the contiguous bottoms were similar to those described on the bed.

The Muscle Hole Bed.—This bed lies on the western side of the channel, south of the Mud Rock. It extends north and south about 3 miles, is from one-half to one-quarter of a mile wide, and comprises an area of 3,060,000 square yards. It is very irregular in shape, and at about two-thirds of its length to the southward it is cut in two by a mud slough. The depth of water is from 12 to 34 feet, and the bottom very irregular, especially about the northern portion, which is cut up into shoals of shells and oysters separated and intersected by narrow mud sloughs, over which the oysters are thinly spread. About the central portion the middle of the bed is comparatively solid, but the eastern and western portions are similar to the northern. The southern part is also broken up considerably, but the bottom is not as irregular as elsewhere. The bottom consists of a stratum of oysters and shells mixed with mud and sand, from one-half foot to 2 feet in thickness, resting on a stratum of hard sand. The shell stratum was thicker along the western part of the bed, where the dark line is drawn on the chart, and decreased in thickness as the eastern edge was approached, where it was hardly observable, and where a substratum of mud was frequently found. East of the bed the bottom is soft mud; to the westward soft sand or sticky mud, with usually a hard substratum. The mature oysters were large and single and of good quality. A very large proportion of young growth was noticed, at least one-half the oysters being of that description. A large number of young, but few drills (*astyris*), were found on the hard bottoms of the central part of the northern portion. On the central and southern portions of the bed the number both of young and drills decreased, while they increased greatly on the western portion. A large amount of red sponge was found, and in greater quantities about the edges of the bed, especially the western, than elsewhere, but its presence appeared to have no effect upon the young or drills. East of the bed the oysters were of the same general character as those on it; the same proportion of young growth was also noticed, but there was almost an entire absence of young and drills. To the westward, as a rule, the oysters were somewhat larger than those on the bed, but as many young growth were present as elsewhere. The number of young and drills was, however, much diminished, as was also the amount of red sponge. The number of oysters to the square yard, the mean of thirty-six observations, was 0.70. The number to the square yard on the area occupied by scattered oysters, the mean of seventeen observations, was 0.07.

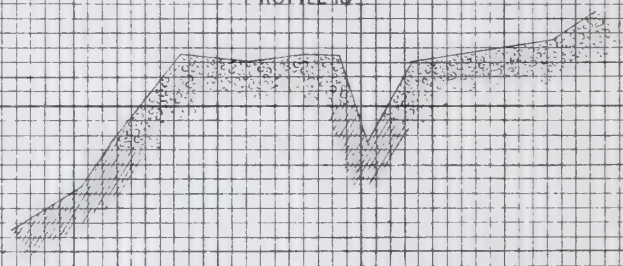
DIAGRAM 3

PROFILE 9



ACROSS PINEY ISLAND BAR

PROFILE 10



ACROSS PINEY ISLAND BAR

PROFILE 11

ACROSS MANOKIN RIVER UPPER BEDS

PROFILE 12

ACROSS MANOKIN RIVER LOWER BEDS

Piney Island Bar.—This bed lies south of Little Island, on the eastern side of the channel and on the western side of the shoal lying between the main channel of the Sound and the channel into the Manokin River. It extends NNW. and SSE. 3 miles, and its greatest breadth, which is near its southern extremity, is about one mile. The bed gradually diminishes in size to the northward, and at that extremity is but one-eighth of a mile wide. Its area is 6,975,000 square yards, and it is unbroken, with the exception of a few sand spaces in the southern portion and a smaller number of mud areas in the northern. About the extreme western border the oysters are in detached groups, with mud sloughs between them, and to the eastward and southward the oysters are more widely scattered and scarce, until they reach the sands or soft muddy bottoms of the channel, when they entirely disappear. The depth of water is from 12 to 36 feet, and, generally speaking, the deeper water will be found on the western and the shoaler on the eastern parts of the bed; there are several holes and sloughs, however, about the middle of the bed. The oysters are not very evenly distributed, as will be seen by the lines on the chart, which indicate the positions of the greatest number, and in the vicinity of the sand and mud areas a smaller number of oysters were found than elsewhere. The bottom is hard, except about the extreme western edge, in deep water, and about the mud holes and sloughs situated in the northern portion. Owing to the depth of water the observations of the character of the bottom were not as numerous as on other beds, but those that were made showed the existence of a stratum of shells and oysters of from one-half foot to 4 feet in thickness, and mixed with mud and sand, over a stratum of hard or soft sand, the former predominating. West and south of the bed the bottom is mud or sticky sand, the latter being found more frequently to the southward than westward. To the eastward the bottom is hard sand. The oysters were single, of moderate size and ordinary quality. A very large proportion—fully one-half—were young growth. Few drills and not many young were found, and both young and drills were in greatest numbers about the extreme southern part, and in least numbers about the northern. A moderate amount of red and gray sponge was found on all parts of the bed, and some of the sponge on the sandy bottoms south of it; where the young oysters were in greatest numbers the amount of sponge was least. West of the bed very few oysters were found, the "rock" rising abruptly from the channel. South and east of the bed the oysters were scarce, and the amount of sponge and grass much increased. The number of oysters to the square yard, the mean of forty-nine observations, was 0.69. The number to the square yard on the area occupied by the scattered oysters was 0.04.

Beds of the Manokin River.—These beds lie on each side of the channel of the Manokin River and extend about 4½ miles from its mouth. The investigation extended as far as Saint Pierre Island, above which point only a few small "rocks," of inconsiderable area, were found. The beds are fifteen in number and comprise a total area of 6,142,000 square yards. Generally speaking, the larger beds are on the northern side of the channel. By reference to the chart it will be seen that beds of more or less area are distributed over the entire river bottom, being separated and intersected by numerous mud sloughs. The character of the individual beds is similar, each being cut up by mud sloughs and divided into small groups and areas of oysters, thus on a small scale reproducing the whole river bottom. The depth of water is from 8 and 10 feet on the upper beds to 27 feet on those off Hazzard's Point. In the channel the depth is 25 and 30 feet off Hazzard's Point, shoaling gradually to Saint Pierre Island, where there is about 13 feet, though there are many deep holes and sloughs where the depth exceeds the average. On the beds the bottom is very irregular, and the change from shoal to deep water sudden and frequent. Generally a thick stratum of oysters and shells were found on the shoals, and where the water deepened a large amount of mud. The oysters appear to be in larger numbers on the beds about the mouth of the river than elsewhere, are very thinly scattered in groups in the channel, and on the extreme upper beds are very scarce. The bottom consists of a stratum of shells and oysters, from one-half foot to 2 feet in thickness. On the northern side of the channel, near the sands, a stratum of hard sand is found directly underneath the shells, but nearer the channel and on its southern side there is an intervening stratum of mud from 1 to 4 feet thick. On the greater part of the beds the oysters and shells are mixed with mud, but in the extreme southwestern portion soft sand is found instead. Many of the beds in the upper part of the river are covered by a stratum of mud about 1 foot thick, and near the southwestern border the oysters and shells were covered by 3 to 6 inches

of sand. In running lines across the river a similarity was frequently noticed in the character of the succeeding surface strata to those of the bottom, as shown by the probe. For instance, in the channel soft mud was found; proceeding inshore a surface of shells and mud, then one of mud or soft sand, and, finally, hard sand was encountered; the bottom on the major portion of the bed is built of similar strata, arranged in reverse order, the hard sand being the lowest. The oysters in the upper part of the river were single and in small clusters; most were young growth, and all were of inferior quality. But few young and few drills were found, and no sponge or grass. On the southern beds the animals increased in size and numbers and improved in quality; a large proportion of young growth was still present, and a larger number of young and drills; a small amount of sponge and grass was found. The scattered oysters in the channel and on the sands were of the same character as those on the beds, but no young, drills, or sponge were discovered.

On the extensive sand shoal south of Piney Island there are no oysters, but much sponge and grass.

The observations for ascertaining the number to the square yard were made only on the southern beds, and consequently must not be considered as giving a just average for the whole area. On the beds, the number to the square yard, the mean of twenty-five observations, was 0.90; on the area occupied by scattered oysters, 0.13.

BEDS OF THE BIG ANNEMESSEX RIVER.

In this river and about its mouth, and on both sides of the channel, are ten beds. The largest are the western ones, situated off Flat Cap Point, and from thence to the eastward the beds gradually decrease in size. They comprise a total area of 2,835,000 square yards.

Though the beds are distributed over the river bottom in a manner similar to those in the Manokin, there is little or no similarity in other respects, except between the western parts of the beds in the mouth of the river and where those farther to the eastward are in proximity to muddy bottoms. In these cases the beds are broken up by sloughs and the oysters piled up about the shoal spots much in the same manner as in the Manokin. The beds in the mouth of the river, especially where they come in contact with muddy bottoms, are also broken by sloughs and the oysters separated into groups. Most of the beds, including nearly all *in* the river, are comparatively unbroken. They are surrounded by sandy bottoms, and, except near the channel where there is mud, such few sloughs as run into them are of sand.

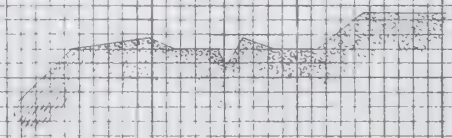
The western beds have from 16 to 33 feet of water over them, and the eastern beds from 7 to 13 feet. Generally speaking, the depth of water may be considered as about 14 feet. The bottom consists of a stratum, about 6 inches thick, of oysters, shells, and soft sand or mud over a stratum of hard sand. The surrounding bottoms consist of strata of soft sand on hard sand, except in the channel where the surface stratum is mud. More mud on the surface was found on the western beds than the eastern. The oysters were small, single, and in small clusters, of poor quality, and with few young, and no drills (*astyris*). A small amount of sponge was found, and the oysters taken in the vicinity of the mud sloughs had blackened shells. The number of oysters to the square yard on the western beds, the mean of seven observations, was 0.56.

Harris Bed.—This is a large bed lying off Flat Cap Point, on the eastern side of the main channel of the Sound, and across the channel into the Big Annemessex River. It extends north and south 2½ miles, and its greatest width is a little more than one mile. Its area is 3,420,000 square yards. The bed is broken in many places, and is separated into four distinct portions by broad spaces of sand that intersect it. All of these portions are more or less cut up by mud or sand sloughs, and especially the middle and larger portion, which contains within its limits several large areas that are occupied by scattered oysters only. The northern portion of the bed is broken by many mud sloughs, and the oysters grow in patches of small area. The other portions are as represented on the chart, the groups of oysters being large and comparatively solid, and the separating sand spaces of more considerable area than where they were of mud. As will be seen by referring to the dark lines on the chart, the oysters are not evenly distributed, but they are found in larger or smaller numbers on the entire area. The bottom is irregular in contour, as will be noticed by reference to the depths of water plotted on the charts. On the northern portion the

DIAGRAM 4

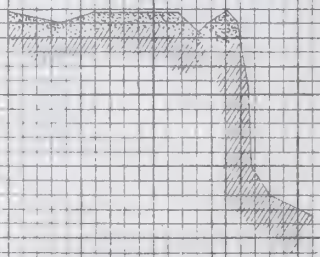
PROFILE 13

ACROSS ANNEMESSEX RIVER BEDS



PROFILE 14

ACROSS HARRIS BEDS



PROFILE 15

ACROSS TERRAPIN SANDS

depth is from 17 to 33 feet, on the central portion from 16 to 24 feet, and on the southern portion 19 to 28 feet. On account of the depth of water over the bed, only a few observations of the character of the bottom could be made, but a sufficient number were obtained to show that it consisted, generally, of a stratum of shells, oysters, and sand, of about 2 feet in thickness, over a stratum of soft sand. The bottom of the northern portion and in the Annemessex Channel was softer, and mud was found on the surface in the place of sand. Except on its northern border, the bed is surrounded by sandy bottoms, though the mud of the channel is not far distant from the western edge of the bed. The oysters were of all sizes and qualities; those on the northern portion were in small clusters and of small size. A few young and a few drills, with a moderate amount of sponge, were found. On the eastern part of the bed the oysters were single, large, and of good quality. Very few young, but few drills, and a moderate amount of sponge and grass were found. On the central parts of the bed the oysters were of moderate size and fair quality. About the middle of the larger portion were an immense number of "young" and a moderate number of drills. Many of the young were injured by the dredge and a large number by drills. A good deal of red, gray, and white sponge was found, but its presence did not apparently influence the number of young on the extreme southern part of the bed, though an unusually large amount of grass and sponge was discovered, and a few drills, yet the number of young was also large. On the western portion of the bed fewer oysters were found, and a smaller number of young and drills. There was no increase of sponge or grass. The scattered oysters east of the bed were large, single, and in small clusters, with a moderate amount of sponge and grass, a few young, and a few drills. To the westward very few oysters were found, but a good many shells and red and gray sponge were brought up by the dredge. It will be noticed that the "strike" or "set" of "young" on this bed was confined to the center of the largest portion, and that very few "young growth" were found on or about the bed, though they were in large numbers a few miles to the northward in the Manokin River. The number of oysters to the square yard, the mean of forty observations, was 0.28. The number on the area occupied by scattered oysters, the mean of twenty observations, was 0.06.

Terrapin Sands Bed.—This is a long narrow bed lying on the shoal from which it derives its name. It is on the western side of the channel, south of the Muscle Hole Bed and Hedge's Strait and opposite Harris' Bed. It extends northwest and southeast $3\frac{1}{4}$ miles, and is, on an average, from one-tenth to one-quarter mile wide. It comprises an area of 1,417,000 square yards. It is divided by spaces of mud and sand occupied by scattered oysters into four distinct portions, the southern one of which is separated from the main bed by a sand space of one-half mile. The northern portion is similar in character to the southern part of the Muscle Hole Bed, the oysters growing in groups and patches, separated by soft bottoms. The remainder of the bed is less broken than any in the Sound, being entirely free from mud and sand sloughs, except about the borders. The oysters are distributed over the entire area, but are in larger numbers on the main and central portion and in smaller numbers on the northern portion than elsewhere. The bottom is irregular, the depth of water ranging from 12 to 23 feet. On the narrow part of the bed the shoal ridge along the eastern edge is very prominent. Except on the extreme northern portion, the bottom is very hard, consisting of shells for over 3 feet, which was as far as the probe could penetrate. An inconsiderable amount of sand and mud was found on the surface. On the northern portion the bottom is softer and the shell stratum thinner; mud sloughs are frequent, but where the groups of oysters were found the substratum was hard. The surrounding bottoms were—to the eastward mud and to the westward principally sand, though many mud holes and sloughs exist, especially on those parts contiguous to the bed. In this direction the oysters are scattered in groups and patches as well as singly, and the muddy bottoms were usually found in the vicinity of those groups. Between this bed and the Muscle Hole Bed the bottom is soft mud, and between the bed and Paul's Bed to the southward the bottom is hard sand.

The mature oysters were large, of good quality, and single; only a few clusters were found. On the northern portion were very few young, young growth, or drills, but a moderate amount of red and gray sponge. On the central portion, about one-third of the oysters were young growth, and a very fair number of young, with a few drills (*astyris*), and a small amount of red sponge were found.

No oysters were found on the soft bottoms east of the beds. Those scattered to the westward were large and of good quality. Very few young and fewer drills were found; where the groups were encountered in a few cases, a moderate number of the oysters were "young growth," but generally there was a marked absence of that class. Sponges were found on the sand in moderate quantity. The number of oysters to the square yard, the mean of fourteen observations, was 0.27. The number on the area occupied by scattered oysters, the mean of twelve observations, was 0.03.

Paul's Bed.—This bed lies on the western side of the channel, opposite the mouth of the Little Annemessex River. It is south of the Terrapin Sands and north of a bed called the Woman's Marsh, with which it is connected. It is similar to the latter bed, being broken in many places by mud and sand sloughs, and with the oysters growing in groups and patches. Its area is 765,000 square yards. The depth of water over the bed is from 14 to 16 feet. The bottom is generally of sand, but many mud sloughs were found. No specimens were obtained from this bed, but the oysters are probably similar to those found on the Woman's Marsh Bed, which will subsequently be described.

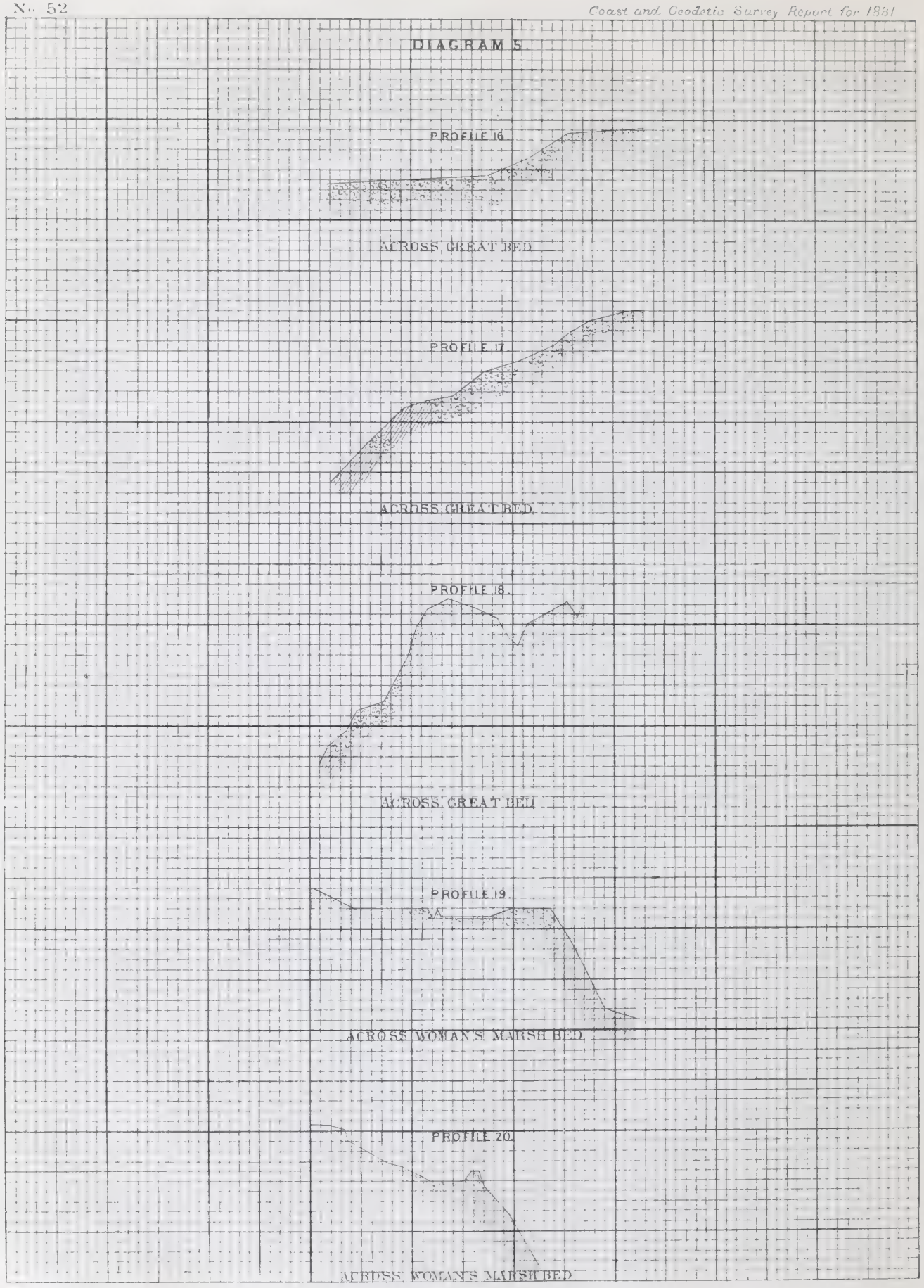
Between Paul's Bed and the Terrapin Sands, on the area covered by the broken lines, very few oysters are found, and on the eastern side of the channel, between Harris' Bed and the bed off Jane's Island Light-House, none at all, presumably on account of the character of the bottom, which is soft, shifting sand.

Bed off Jane's Island Light-House.—To the northward of the channel into the Little Annemessex River, and to the eastward of the channel of the Sound, there is a bed extending from the channels to and over the shoal about the light-house off Jane's Island. It comprises an area of 1,800,000 square yards, and is unbroken except about its southern and western boundaries, where it joins the channels. The depth of water is from 17 to 47 feet, the deep water being found on the western edge and the shoal water in the vicinity of the light-house and shoal extending from it to the westward. The oysters were unevenly distributed and were in largest numbers about the central portion of the bed in 3½ and 4 fathoms water. Along the edges of the bed where it is broken the oysters are scattered in groups and are in smaller numbers. The bottom is hard and of sand and shells, except near the channels, where some mud was found over the hard stratum. West of the bed there is soft mud and east of it hard sand. The oysters were single or in clusters of two or three, the single oyster of moderate size predominating. The young were no more evenly distributed than the mature oysters, large numbers existing on some parts of the bed, and very few on others. Those parts farthest from the channel appeared to have the largest proportion of young to mature oysters. A few sponges and some grass were found on the northern part of the bed.

The Great Rock.—On the eastern side of the Sound off Great Fog Island, and south of the channel into the Little Annemessex River, lies the largest oyster bed in either Tangier or Pocomoke Sound. It is called the "Great Rock," and comprises an area of 8,505,000 square yards. Its greatest length is 3¾ miles, and its greatest width, 1¼ miles. It is irregular in shape, and about two-thirds of its length to the southward it is divided into two portions. Originally these portions were widely separated, but, through the action of natural causes and the dredges, each portion has been extended until where the bottom was hard they have become united, and probably in the course of time the union will be more complete. The depth of the water over the bed can be seen by referring to the chart. The inner limit of the northern and larger bed is approximately indicated by the 3-fathom curve, and as no oysters were found in deeper water than 8 fathoms, the depth of water over the bed is, therefore, within those limits. Generally speaking, the deepest water is over the lower part of the larger portion. The inner limit of the smaller portion of the bed is not as well defined as that of the other, and some of the oysters on this area are found in 2 fathoms of water, and on and about the 2-fathom shoal off Great Fog Island. The muddy bottoms of the main channel lying in from 5 to 9 fathoms of water define the western limit of the bed, and a deep mud slough which separates it from the bed off Jane's Island Light forms the northern boundary.

The northern and western portions of the bed are somewhat broken, the oysters growing in groups, which decrease in size and number as the edge of the bed is approached. Similarly towards the eastern and southern limits the oysters begin to scatter in groups and singly, but the main bed may be considered solid, only a few mud sloughs and sand spaces of inconsiderable area existing in

DIAGRAM 5.


PROFILE 16.
ACROSS GREAT BED.
PROFILE 17.
ACROSS GREAT BED.
PROFILE 18.
ACROSS GREAT BED.
PROFILE 19.
ACROSS WOMAN'S MARSH BED.
PROFILE 20.
ACROSS WOMAN'S MARSH BED.

the interior. The oysters are distributed over the entire bed, but not evenly, the largest number being found in the vicinity of the dark line marked on the chart. The bottom is hard, of shells and sand; the oysters on the surface had a small amount of mud with them, the thickness of which was not uniform, but did not exceed a few inches. As the channel and northern boundary are approached the bottom becomes softer and more mud is found; on the eastern and southern portions of the bed the sand increased; north of the bed the bottom is mud, to the eastward and southward, hard sand, and to the westward, soft mud. On the bed itself the substratum of the bottom is probably hard sand, but owing to the great depth of water it was impossible definitely to ascertain the character of the substratum, except in a few isolated cases. The oysters found were single, of moderate size, and good quality; occasionally small clusters of two or three were discovered. Many young were found, but they were not evenly distributed, being in larger numbers about the central portion of the bed and decreasing as the edges were approached. On the southern and smaller portion the young were comparatively scarce. A moderate number of young had evidently been destroyed by the dredges, and large numbers were injured by drills; many drills were found attached to the oysters, and where the bottom was clean the drills were generally in direct proportion to the young, but where the red or gray sponge or grass existed there was a marked diminution of the number of young and a moderate diminution of the number of *astyris*. The sponge and grass were found in considerable quantities about the western and southwestern edges of the smaller portion, and to a less extent on the main bed. As the bottom became soft or muddy, both young oysters and *astyris* disappeared. Though the bed is so large and so favorably situated for production the oysters are not very plentiful, the number to the square yard, the mean of thirty-six observations made at different points, being but 0.16. The scattered oysters to the eastward are much larger and finer than those on the beds. They are singly on the sands, the distances separating them being proportional to the distance of the oysters from the main bed. To the southward and eastward the oysters are not so fine, especially those in the latter locality, where they grow on the edge of the mud, and have discolored shells and an unhealthy appearance. The number to the square yard, on the area occupied by scattered oysters, was 0.04.

The Woman's Marsh Bed.—This bed lies on the western side of the Sound, opposite the Great Rock, and is next to it in size, comprising an area of 6,975,000 square yards. It is irregular in shape, extends north and south along the edge of the channel for $4\frac{3}{4}$ miles, and is a little less than one-half mile broad. All parts of the bed are broken in many places, and this is especially the case about the middle portion. Large spaces of sand and smaller ones of mud are frequently met, and the oysters grow in groups of considerable size, separated by these spaces, except about the locality of the dark line drawn on the chart, where the bed is nearly unbroken.

The depth of water is from 13 to 22 feet; over the southern and middle parts of the bed the usual depth was about 19 feet, and on the northern portion about 14 feet was found. Generally speaking, the deeper water is near the channel, but on the extreme eastern edge of the bed the water suddenly shoals, usually to 16 or 17 feet, and sometimes to as little as 2 fathoms. Immediately to the westward the water deepens rapidly. The ridge is very narrow and on or near it the largest number of oysters were found; hence the dark line on the chart shows, approximately, its position. The shoal water is found on the western part of the bed, and the deep water over the soft bottoms and mud sloughs.

The oysters are spread over the entire area, with the largest number along the eastern edge of the bed, where the bottom is hard, though they are scattered over and about the mud and sand spaces. The bottom was hard, of shells and sand, except where the mud sloughs occurred, when the covering of shells was very light, and the mud underneath of considerable thickness. A little mud was found on the solid parts of the bed, the amount depending upon the distance from the channel or interior mud spaces. Very few observations were made of the substratum, but it is probably of sand, the bottom to the westward being of that description. East of the bed the bottom was soft mud. The oysters were large and single, occasionally of small clusters and of very good quality. Many young and many drills were attached to them and the old shells. The young were very unevenly distributed, the largest number being found about the locality indicated by the dark line on the chart and on the hard bottoms. The drills were similarly distributed, being usually in proportion to the young, though exceptions to this rule were more frequent than on the

Great Rock. Both young and *astyris* were found in greater numbers on the southern portion of the bed than on the northern. Along the eastern edge of the bed on the hard bottoms the red sponge was found, and a smaller amount on the central part; very little was found where the bottom was soft, and the number of young diminished where the amount of sponge was excessive. The number of oysters to the square yard, the mean of thirty-two observations made on different parts of the bed, is 0.24, which is somewhat larger than on the Great Rock, probably on account of shoaler water in which the dredging was done. The oysters scattered around the bed are similar to those on it, though they grow somewhat larger and have cleaner shells. To the westward the young were present in moderate numbers and with the usual proportion of *astyris*. But little sponge or grass was found in this direction, but to the southward both increased, and young and *astyris* disappeared. The number to the square yard, on the area occupied by scattered oysters, the mean of thirteen observations, was 0.06.

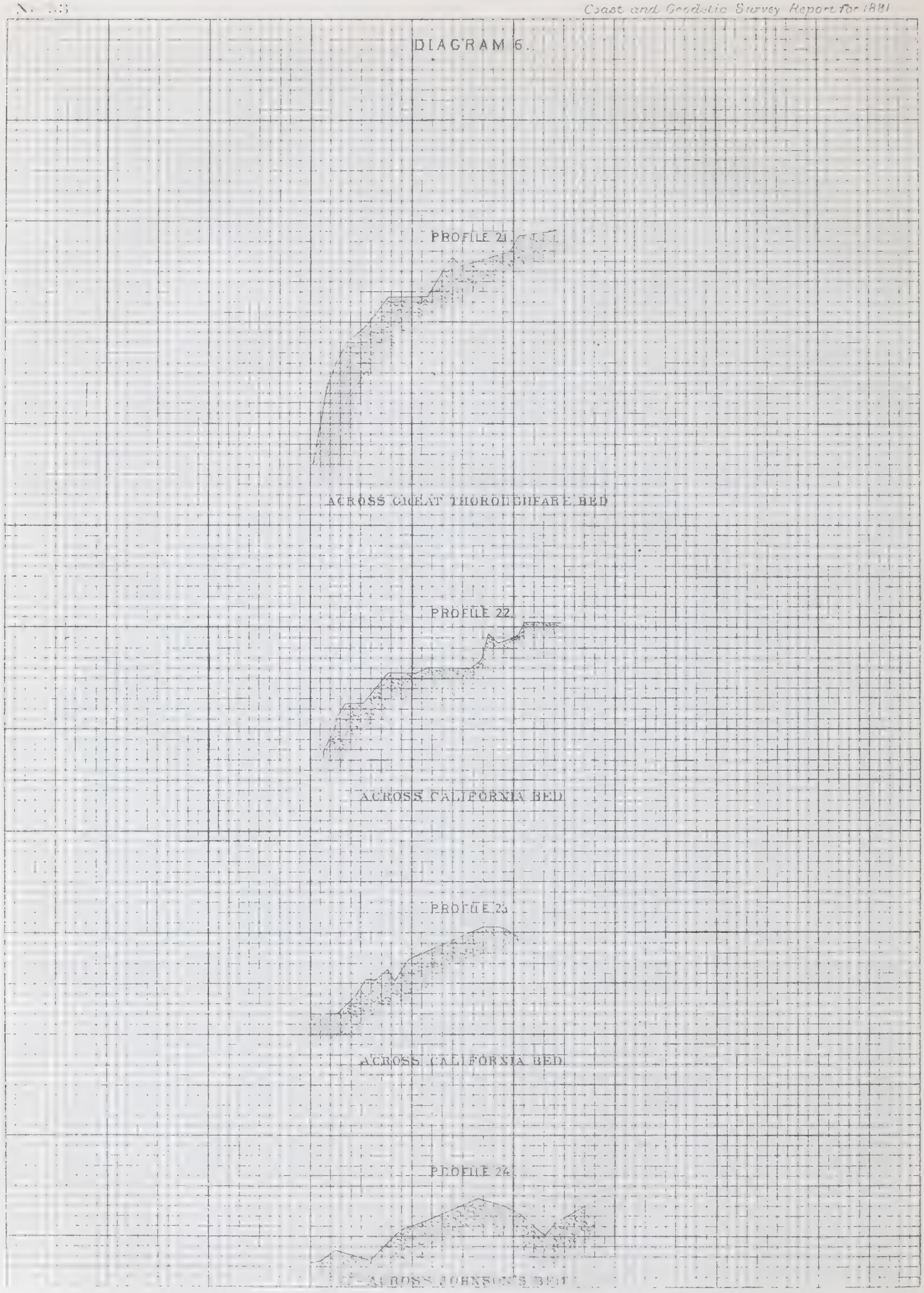
Thoroughfare Beds.—On the eastern side of the Sound, opposite Little Fox Island and south of the Great Rock, are two beds of moderate size, called the Little Thoroughfare and Great Thoroughfare. The area of the former is 720,000 square yards, and the area of the latter, 1,597,000 square yards.

The depth of water over the Little Thoroughfare is from 15 to 34 feet, the deep water being found over the western and southwestern portion and shoaling from thence gradually to the northward and eastward. Over the Great Thoroughfare the depth is from 16 to 54 feet, the deep water being found on the western and northwestern edge of the bed and shoaling to the southward and eastward. The space separating the beds is about one-fourth of a mile wide, and has over it a depth of water from 20 to 40 feet. The beds are unbroken except about the edges, where the oysters are scattered. On the western side of the Great Thoroughfare, where the bed extends to the soft muddy bottoms, the usual detachment of the oysters into groups is noticeable, but about the other boundaries, where the bottom is hard sand, the oysters are distributed more thinly and the breakage not distinguishable. The distribution of oysters was more even on the Great Thoroughfare than on the Little Thoroughfare bed, the largest number on the latter bed being found on the western part, while on the former the largest number was about the central portion. The bottom on both beds is hard, consisting of a stratum of shells and oysters 1 or 2 feet thick, over a stratum of sand. Very few observations of the character of the substratum were made, the depth of water being too great to permit it, but as the bottom as far as the channel was hard, and large numbers of shells and oysters were brought up from the western border, it is probable that the shell stratum continues as far as the muddy bottoms.

The oysters were of moderate size, usually single, but occasionally in small clusters. Large numbers of young were found on the extreme northern part of the Little Thoroughfare and on the central and western portions of the Great Thoroughfare bed, while very few young were found on the eastern part of the latter. Some of the young had been destroyed by dredges and a few by drills, though not many of the latter (*astyris*) were discovered. A small amount of sponge and grass was found about the edges of the beds. The number of oysters to the square yard, on the Little Thoroughfare, the mean of nine observations, was 0.14. On the Great Thoroughfare, the mean of ten observations was 0.11. On the area occupied by scattered oysters, the number to the square yard, the mean of seven observations, was 0.05.

The California Bed.—This bed lies on the eastern side of the channel, opposite the thoroughfare into Pocomoke Sound, and south of the Great Thoroughfare bed. It extends in a north and south direction about 3 miles, and is very irregular in shape. About the center it is divided by a mud slough one-eighth of a mile wide. The area of the bed is 3,915,000 square yards. Along the western part of the bed runs a narrow ridge, which is comparatively unbroken and appears to be the original of the bed defined on the chart. To the eastward of this ridge the stratum of oysters and shells is thinner, though the shells and oysters are spread quite evenly, diminishing in numbers as the edge of the bed is approached. West of the ridge and also in the vicinity of the dividing mud slough, the bed is broken into detached groups of oysters and shells. The depth of water is from 17 to 39 feet, the deepest water being found on the northwestern and western parts of the bed. Except about the western border, the bottom is hard. Only a few observations of the character of the bottom could be made, either on the bed or in its vicinity, the depth of water being

DIAGRAM 6.


PROFILE 21
ACROSS GREAT THOROUGHFARE BED
PROFILE 22
ACROSS CALIFORNIA BED
PROFILE 23
ACROSS CALIFORNIA BED
PROFILE 24
ACROSS JOHNSON'S BED

too great. Such as were obtained showed a substratum of hard sand, and it is probable that the substratum is similar on all parts of the bed.

On the central portion of the bed the oysters were single, of moderate size, and fair quality, but not numerous. Very few young, very few *astyris*, and but little red or gray sponge were discovered. On the western part of the bed the oysters, though similar in character, were in greater numbers, young and old, and where the number of young increased, a proportional increase in the number of *astyris* was noticed. On the eastern part of the bed the number of oysters, young and *astyris*, considerably diminished. About the edges of the bed the grass, sponge, and sea-weed increased, and where this occurred a decrease in the number of young was noticed. The number of oysters to the square yard, the mean of thirty-six observations, was 0.21. On the area occupied by scattered oysters, the number to the square yard, the mean of eighteen observations, was 0.06. On account of the depth of water, and other unfavorable circumstances, both results must be regarded as a much rougher approximation to the real number than in the cases of the beds previously described.

Johnson's Bed.—This bed lies on the eastern side of the Sound, immediately to the westward of the 3-fathom shoal off Watt's Island Light-House. The bed is separated into two portions, of nearly equal area, by a dividing space of sand which extends north and south, following the general direction of the bed. Each portion is about one-eighth of a mile, and the northern and southern extremes are separated one mile and a quarter. The area of the bed is 1,395,000 square yards. The bed is unbroken, except about the edges, and the oysters exist on the entire area, though unevenly distributed, the larger number being found about the center of the bed. The bottom is comparatively regular, the depth of water being from 24 to 36 feet, the greater depths being on the western part and the least on the eastern part of the bed. On account of the depth of water and unfavorable nature of the weather during the examination of this bed no observations of the character of the bottom were made. The lead showed a hard surface stratum, except about the western edge, where mud was found. The oysters were large and single with many young and drills (*astyris*). Very little sponge was found on the bed, but on the shoal to the westward and between Johnson's and the California Beds there was a large amount of it. Very few oysters were found in this area. The number of oysters to the square yard, the mean of four observations, was 0.19.

East of Johnson's Bed is a small rock, called "Parker's Hill," which for want of time was neither surveyed nor examined. It is of little importance and seldom worked.

Oak Hammock Rocks.—These beds are situated on the western side of the Sound at the entrance to and in a large mud slough, which extends as far as Queen's Reach into the sand shoal surrounding Tangier Island. Each of the beds has a distinguishing name and is separated by mud sloughs from the others, but as the areas are small and the outlines of the rocks very indefinite I have included all of them under the name by which the assemblage is generally designated. The beds extend northwest and southeast about three-fourths of a mile, and the area is irregular in shape. The depth of water is from 9 to 24 feet, and the bottom is a stratum of shell, mud, and sand, over a stratum of mud. Underneath this mud, where it was not too thick for penetration, we found a hard stratum. The majority of the oysters were old, of small size, single, and in small clusters. Neither young nor drills (*astyris*) were found, and but a moderate amount of sponge. To the northward and westward of the beds the oysters are scattered in the mud in groups and patches. The total area of the bed is 600,000 square yards.

On the sand shoal between the Oak Hammock beds and the Woman's Marsh no oysters have ever been found.

DENSITIES.

Specimens of the bottom water taken on each bed, at all stages of the tide, have been tested with the hydrometer and its readings reduced to a standard temperature of 60° Fahr. These results show a maximum density of the waters of Tangier Sound of 1.0164, which was found in the lower part, about the California Rock, at half flood-tide. The minimum density of 1.0111 was

found in the upper part of Fishing Bay, with the tide three-quarters ebb. The following table shows the maximum and minimum density on each bed, with state of tide and remarks:

Comparison of densities—Tangier.

[The figures represent the excess of density over that of distilled water, which is represented as 1.000.]

Bed.	Max. density.	Tide.	Remarks.	Diff.	Min. density.	Tide.	Remarks.
Fishing Bay	1.0136	High water	Southern part	.0025	1.0111	¼ and ¾ ebb	Extreme northern part.
Were Point	1.0139	½ flood	In channel to Hooper's Straits	.0022	1.0117	Low water	
Shark's Fin	1.0143	High water	Edge of main channel	.0025	1.0118	¾ ebb	Middle of bed.
Nanticoke M. G	1.0136	High water	West of channel	.0017	1.0119	½ ebb	Middle of bed.
Clump Point	1.0118	¾ flood	Only one specimen				No specimen.
Horsey's Bar Tyler's Rock Drumming Shoal	1.0132	¼ ebb	Only one specimen	.0012	1.0120	½ flood	Only one specimen.
Grass Tangier	1.0144	¼ flood	In the channel	.0024	1.0120	Low water	Middle of bed.
*Turtle Egg Rock	1.0120	¼ flood					
Chain Shoal	1.0145	¼ flood		.0022	1.0123	¾ flood	
Mud Rock	1.0144	¾ flood		.0008	1.0136	¾ ebb	
Muscle Hole	1.0157	¼ ebb		.0012	1.0145	Low water	
Piney Island Bar	1.0150	½ ebb	South of beds	.0019	1.0131	½ ebb	Middle of bed.
Manokin River	1.0152	¼ ebb	Lower beds	.0014	1.0128	½ ebb	Upper beds.
Big Annemessex	1.0151	High water	Western beds	.0007	1.0144	½ ebb	Eastern beds.
Harris Rock	1.0153	¼ ebb	Southern beds	.0007	1.0146	High water	
Terrapin Sands	1.0159	¾ ebb	Strong southerly winds	.0015	1.0144	½ flood	Light southerly breezes.
Rock off Jane's Island	1.0156	½ ebb		.0013	1.0143	¾ flood	
Great Rock	1.0159	¼ flood		.0011	1.0148	High water	
Woman's Marsh	1.0160	¾ ebb	Opposite opening between Tangier and Smith's Island.	.0016	1.0144	¾ flood	
Little Thoroughfare	1.0158	¾ ebb		.0009	1.0151	½ flood	
Great Thoroughfare	1.0157	½ flood, ¾ ebb		.0005	1.0152	½ flood	
California	1.0164	½ flood		.0012	1.0152	¾ flood	
Johnson's Rock	1.0161	½ flood		.0013	1.0148	½ ebb	
Oak Hammock	1.0160	¼ ebb		.0002	1.0158	½ ebb	

*All specimens taken on flood. This is minimum density.

By consulting the table it will be seen that the state of the tide has but little influence upon the density, though the depth of the water has, and the prevalence of strong winds may increase or diminish it. There is shown a gradual and constant increase of density as the southern portion of the Sound, where it opens upon the Chesapeake, is approached. There is also an increase of density when in the vicinity of the openings into the bay, and a decrease in the various rivers and off their mouths.

Though the density of the water increases, yet the difference between the maximum and minimum density steadily decreases to the southward, showing that the oysters on the northern beds are exposed to greater fluctuations of density, and probably salinity, than those on the beds to the southward.

There were no heavy rains during my stay in the Sounds, and the densities given therefore show only the condition of the water in that respect during dry weather. I was informed that there was a noticeable change in its character about the mouths of the tributaries of the Sounds after a heavy rainfall, and the effect upon the oysters was also perceivable.

The difference between the maximum and minimum density of the Sound amounts to 0.0053; but the difference between the maximum and minimum density on each bed will give a more correct idea of the changes to which the oysters are exposed. The greatest difference is 0.0025, which occurs on the Shark's Fin and Fishing Bay Beds, and the least difference on any of the main beds is 0.0009 on the Little Thoroughfare.

It would be perhaps still more correct to divide the Sound into several parts and consider the fluctuation of density over them, thereby assembling a larger number of observations. Throwing out the Fishing Bay beds, which by their position are removed to a great extent from the condi-

tions affecting the other beds, and including all those south of Clay Island as far as Piney Island bar, where the influence of the Manokin and Annemessex Rivers would be felt, the difference of density amounts to 0.0028.

The difference of density over the beds south of Little Island and north of Little Annemessex River is 0.0031.

The difference of the beds south of Jane's Island Light is 0.0020.

These differences show that the greatest fluctuation is over the beds in the middle of the Sound, and is probably due to the influence of the Big Annemessex and Manokin Rivers and the waters entering by Kedge's Strait.

Throughout the Sound there is a marked difference between the densities of the water taken about the latter part of August and the first part of September and those taken in October. This difference is given in the following table:

Bed.	Date first observation.	Date second observation.	Difference in density.	Bed.	Date first observation.	Date second observation.	Difference in density.
Flushing Bay	Aug. 24	Oct. 5	.0018	Harris's Rock	Aug. 29	Oct. 1	.0005
Were Point	Aug. 24	Oct. 5	.0014	Great Rock	Aug. 30	Sept. 28	.0007
Nanticoke Middle Ground	Aug. 26	Oct. 5	.0014	Woman's Marsh	Aug. 30	Sept. 23	.0008
Bed north of Turtle Egg Island	Aug. 26	Oct. 4	.0016	Great Thoroughfare	Sept. 5	Sept. 28	.0007
Chain Shoal	Aug. 27	Oct. 8	.0011	California	Sept. 6	Sept. 26	.0009
Piney Island Bar	Aug. 28	Oct. 4	.0010	Johnson's Rock	Sept. 6	Sept. 20	.0010
Manokin Bed	Aug. 27	Sept. 30	.0017				

The earlier observations show the least density.

It will be seen by the table that the observations were made at from two weeks to six weeks apart; that, generally speaking, the amount of difference in the densities increases with the interval between the observations, and that the northern beds and those in the rivers are exposed to greater fluctuations of density than the neighboring ones in the Sound. If the change of density over the beds, as shown by these tables, represents with approximate accuracy the change of salinity of the water, the fluctuation is too slight to seriously affect the beds or oysters; but if the slightness of the change is due to organic matter held in solution by the waters of the ebb tide, which would replace the salt of the flood, there may be a much greater difference in the salinity of the flood and ebb than has been indicated by the hydrometer.

CURRENTS.

The general set of the currents in the Sound is north and south, following the main channel and diverging slightly about the mouths of the tributaries and straits.

In the following statements regarding the currents the influence of the wind has not been eliminated, and accounts for many irregularities, both of velocity and direction, and about slack-water, especially of the windward tides, this influence was most apparent.

In Fishing Bay the currents follow the general bend of the shores and channel, setting over the lower portion, on the flood, to the northward; over the middle portion to the northward and westward, as far as Fishing Point, and above that point and over the upper part of the bay, setting to the northward and eastward. The maximum observed velocity of the flood current was 0.38 of a mile per hour. The ebb in each portion of the bay sets in an opposite direction to the flood.

The currents about the northern part of the Were Point bed were measured during and after strong northeast winds, which accounts for the set to the southward and westward, and also for the slight velocity of the ebb, which was only 0.15 of a mile per hour, the northeast wind having lasted for two days and having driven a good deal of the water out of Fishing Bay.

Over the Shark's Fin the flood current sets to the northward and the ebb to the southward and eastward, most of the latter apparently coming from Hooper's Straits. Its maximum velocity

was 0.4 of a mile per hour. The observations of the strength of the flood current made on this bed were too much influenced by the wind to be considered reliable, but the velocity immediately south of the bed was 0.5 of a mile per hour.

The currents of the Nanticoke Channel and over the adjacent beds set to the northward and eastward on the flood, following the bend of the channel, with a maximum velocity of 0.6 of a mile per hour. The ebb over the major portion of the Middle Ground sets to the southward, with a velocity of 0.3 to 0.4 of a mile per hour on the first quarter, until it meets the current of the Wicomico, when it turns to the westward. A strong current sets in and out of Rock Creek; over the Drumming Shoal and Cedar Rocks the current sets NNE. on the flood, with a velocity of 0.4 of a mile per hour, and SSW. on the ebb tide, with a velocity of 0.6 of a mile per hour.

Over the beds south of the Shark's Fin and Cedar Rock, and north of Piney Island bar and Kedge's Straits, the general set of the flood is to the northward, with an inclination towards Holland's Straits when about Turtle Egg Island, and tending to the northward and westward off the Little Thoroughfare. The general set of the ebb while in the channel is to the southward, but on the Turtle Egg Island, Mud and Muscle Hole Beds the set is to the southward and eastward. The strength of these and all currents in the Sound is much influenced by the winds that have prevailed during the immediately preceding days, and which it was impossible to eliminate in the space of time covered by this investigation. Over the western beds, above Kedge's Straits, the maximum observed velocity of the flood was 0.8 of a mile per hour, and a mean of all the velocities of the flood current was 0.4 of a mile per hour. The maximum observed velocity of the ebb current was 1.0 mile per hour, and the mean of all velocities of the ebb was 0.3 of a mile per hour.

Over the Chain Shoal the maximum velocity of the flood was 0.37 and the mean velocity was 0.3 of a mile per hour. The maximum velocity of the ebb was 1.0 mile and the mean velocity 0.5 of a mile per hour.

The flood current over Piney Island bar sets NNW., or about in general line with the Sound at that point. Its velocity on the third quarter, during and after northerly breezes, was 0.1 of a mile an hour, and probably it is seldom less than that. The ebb current over the northern part of the bed sets SSE., but tends to the southward over the southern part. The maximum velocity of the ebb during and after northerly breezes was 1 mile per hour and the mean of all observations, taken under similar circumstances, gives a velocity of 0.4 of a mile per hour.

In the Manokin River the current follows the general trend of the channel, the flood setting to the northward until above Hazzard's Point, and then to the northward and eastward. The ebb sets southwest, and, when it strikes the shoal off Piney Island, curves somewhat to the southward. The currents were measured during light or gentle northeasterly breezes. The maximum velocity of the flood was 0.4 of a mile per hour and the mean of all the velocities of the flood 0.2 of a mile per hour. The maximum velocity of the ebb was 0.5 of a mile per hour and the mean velocity 0.2 of a mile per hour.

In the Big Annemessex River the current sets to the eastward on the flood tide and to the westward on the ebb, curving to the southward on the latter as it approaches the mouth of the river. The maximum velocity of the flood current was 0.4 and the mean velocity 0.25 of a mile per hour. Of the ebb the maximum velocity was 0.5 and the mean velocity 0.33 of a mile per hour.

The flood current sets over Harris Rock to the northward with a maximum velocity of 0.33 and a mean velocity of 0.2 of a mile per hour. The ebb, being somewhat influenced by the current out of the Annemessex and the sweep of the main current of the Sound, sets to the southward and westward, with a mean velocity of 0.2 of a mile per hour. The maximum velocity observed was but a slight increase of the mean.

Over the Terrapin Sands the flood sets northwest, with a maximum velocity of 0.9 and a mean velocity of 0.7 of a mile per hour. The ebb sets southeast until near the buoy marking the shoal, where it turns to the southward. Its maximum velocity was 1 mile and its mean velocity 0.9 of a mile per hour. The currents over the Terrapin Sands were measured during spring tides, and after light breezes and calms had prevailed for several days.

Over the Woman's Marsh Rocks the flood sets about NNW. until in the vicinity of Horse Hammock, where it turns to the northward and eastward. The ebb sets SSW. over the upper part of the bed, and to the southward and eastward over the lower. There is a strong set in and

out of the opening between Tangier and Smith's Islands. The maximum velocity of the flood was 0.7 and the mean velocity 0.6 of a mile per hour. The velocity of the ebb was, maximum 0.8 and mean 0.4 of a mile per hour. These currents were also measured during spring tides. Along the eastern side of the Sound, below Jane's Island Light and over the several beds located on the eastern edge of the channel, the general set of the current is to the northward on the flood and to the southward on the ebb. The flood sets a little to the eastward or westward of north as the channel changes in direction, and about the northern part of the Great Rock sets strongly to the northward and eastward into the Little Annemessex. The ebb current out of that river forms a strong tide rip where it joins the main current due east of Jane's Island Light and on the northern part of the bed off that light. The general set of the ebb is the reverse of that of the flood, and both currents follow the trend of the channel.

Through the Thoroughfare, opposite the California Rock, the flood sets east into Pocomoke on the first three quarters, and west on the last quarter. On the ebb the set is westward on the first three and eastward on the last quarter, and this irregularity is communicated to some extent to the waters over the California Rock.

The maximum velocity of the flood current on the eastern side of the Sound, below the Little Annemessex, was 0.3 and the mean velocity was 0.2 of a mile per hour. The maximum of the ebb was 0.8 and the mean 0.7 of a mile per hour. Most of these currents were measured during northerly winds, which would increase the ebb and diminish the flood currents, and probably they are more equal than the observations show them to be.

Over the Oak Hammock Rocks the flood sets to the northward and westward, and the ebb to the southward and eastward, with a velocity of from 0.1 to 0.2 of a mile per hour.

Reviewing the currents, it will be seen that the strongest on both tides were those over Terrapin Sands during the spring tides, their velocity being about one mile per hour. As the observations over the Sound were made during various states of the weather and of tide, the highest velocity obtained is probably as great as ever sets over any of the beds.

The velocity, except within wide limits, however, is not so important to the oysters as the direction of the current, and that has been ascertained with, I hope, sufficient exactness to assist, so far as it can, in the study of the beds.

DEPOSIT.

It would require a much longer period of observation than was at our disposal, and a much more extensive and careful investigation of the character of the water and bottom of the Sound than I was enabled to make, to allow me to speak with authority or exactness upon this subject; but from the information collected from the most intelligent of the oystermen whose experience on the beds was considerable, I am of the opinion that there is little or no systematic deposit going on upon any of the beds of the main Sound. There must be some sediment contained in the waters of the rivers and creeks, but it appears to be deposited on those beds near their mouths. In the upper part of Fishing Bay, on the Clump Point Rocks, Middle Ground of the Nanticoke, in the Manokin and Big Annemessex Rivers, there is a larger amount of mud in the surface and underneath than elsewhere in the Sound. Those beds lying in deep water are particularly free from an undue proportion of mud on the bottom, the shoalest beds having the thickest mud covering.

If there was a constant and increasing deposit upon the beds they would long ago have disappeared, or at least have become of much smaller area, but the reverse is the case, the beds increasing in area constantly.

They are, however, exposed to one species of deposit which is very injurious. Heavy gales occurring in winter and summer frequently tear up the large quantities of grass, sea-weed, and sponge on the sand shoals about the Sound and deposit it upon the beds. If this occurs in summer, when there are a smaller number of dredgers at work, the effect is very injurious, the "cultch" being covered, and the young, if spawned, smothered by the grass, weeds, sand, and mud which it collects. The California Rock, Piney Island bar, and Manokin beds are those most subject to this evil.

The gales also have the effect of covering the scattered oysters on the leeward sands, which

process is called "sanding," and, from what I could learn, appears to be a very injurious one. The oysters are buried, and the bottom becomes smooth and hard. Where at least thirty bushels of oysters could be taken previous to a gale, not one oyster could be found subsequent to it. The winter gales have the greatest effect, owing probably to their greater severity, and direction, which is from the northward and westward. The "sand" oysters are found in largest numbers on the eastern shores of the Sound, and about Kedge's and Hooper's Straits; consequently they would feel a northwesterly gale much more than one from the opposite direction. They are said not to recover from the "sanding" for several months, and upon their reappearance are noticeable on account of the whiteness of their shells. Though there were several very heavy blows while we were in the Sound, they were not of sufficient severity to produce the effect spoken of, and if they had been I should not have been able to detect it, on account of the shallowness of the water in which the scattered oysters lie, which prevented the schooner's dredging for them.

EFFECT OF GALES AND ICE.

As there was no opportunity for me to investigate this question in person, the examination of the beds having been accomplished during the summer and autumn months, the following information is derived from the queries put to the oystermen and persons inhabiting the shores of the Sound. The heaviest gales during the winter season are from the northward and westward; during the summer season, from the southward, and southward and eastward. The gales from the eastward, southward and eastward, and southward, cause an increase of depth over all the beds, amounting sometimes to 2 feet, and the northerly and westerly gales a contrary effect, but not sufficient to leave any of the natural beds uncovered, except one or two small patches in Fishing Bay. Gales from any direction cut away considerably the leeward shores and points, especially when they are of a sandy nature. Those parts of the Sound suffering most in this respect are Bishop's Head, Haines' Point, and Diel's Island, Little Island, the shores about and near Jane's Island Great Fox Island, the shores about Horse Hammock, and the southern part of Watts and Tangier Islands. Cod Harbor, in Tangier Island, is said to be filling up with the washings of the sand-spit to the southward.

Though it is said the amount washed away from these points is considerable, no additional deposit was ever noticed on the beds, nor did the gales appear to affect them in any way other than has already been described, except in conjunction with the ice in the winter.

Ice never rests upon the main beds except in a few isolated cases where there happens to be a very shoal spot on the bed; as, for instance, occasionally the ice will ground on some of the small rocks in Fishing Bay and once in a while on the Woman's Marsh, but not often. The injury done the oysters by the grounding depends upon the length of time the oysters are in contact with the ice. If it only touches in a few places not much harm is done; indeed, it is supposed to protect the majority on the bed by covering them, but where there is a contact all over the "rock," the oysters are killed in a short space of time. The number of points in the Sound where it is possible for the ice to rest is inconsiderable, and not many of the animals are destroyed by the grounding of the ice, though they are affected seriously by its long continued presence.

The winter gales break up the ice fields and pile them up in immense masses on the leeward shores and over the adjacent beds. The Shark's Fin Bed suffers particularly in this respect. A good deal of damage is done to the shores by the ice, and the oysters feel the effect, showing it by becoming what is called "winter killed," or poor and weak, having a slimy, sickly appearance when opened. Many die on the beds from this cause, and after the disappearance of the ice ten days or two weeks must elapse before they are fit for marketable purposes. Ordinary cold weather and a moderate amount of ice is said to improve the fishing, the oysters appearing to be drawn more to the surface of the bed and the shells to sink more toward the bottom. My informants said this effect was quite noticeable.

No one that I was able to interrogate had ever seen an oyster frozen *in the water*, and the impression was that so long as the oysters were covered they would recover from any ill effects of ice or ordinary cold weather.

POCOMOKE SOUND.

Pocomoke Sound extends from Watts' Island in a north-northeasterly direction 12½ miles.

The main channel is narrow with a varying depth of water, the main body of the Sound being covered by shoals with from 7 to 18 feet of water over them. Long sand-spits make off from most of the points and islands and separate the channels into the different creeks from each other. The Sound is about 9½ miles broad from shore to shore about its middle, but the channel occupies only 1¼ miles of this space.

The change of depth is gradual, except between Watts' and Beach Islands, near the southern extremity of the Sound, where the change from deep to shoal water is sudden. About the upper and northeastern portion the depth is more uniform, the deep channel shoaling to about 12 feet, and that depth being but slightly diminished close to the shores.

The beds do not, as in Tangier Sound, cover the shoals on each side of the channel, the majority being found on the eastern side, and only two beds to the westward of that part of the channel where the water is deeper than three or four fathoms.

The total area covered by oysters, to a greater or lesser extent, in this Sound is 34.12 square nautical miles. This area is that inclosed on the chart by the boundaries of scattered oysters, and is but approximate, as previously explained. The solid beds, comprising all parts of the Sound where oysters were found in a greater number than 0.1 to the square yard, or where the bed was found to be to all intents solid "oyster-rock," or comparatively unbroken, embrace a total area of 4.52 square nautical miles. The groups or rocks are not always contiguous, being frequently separated by the channels into the different creeks and rivers and by mud sloughs and spaces, and in only one case have the beds extended across a channel, and peculiar circumstances account for that exception. Generally speaking, they will be found to lie on each side of the main channel in the Sound and on each side of the channels into the rivers. Taking them in order from the mouth of the Pocomoke River to the entrance of the Sound, there are seventeen of a sufficient size to justify a separate consideration and name; and I have called them by the names given by the local oystermen to the solid "oyster-rock," which was probably the origin of the bed.

They are: The Old Rocks and New Plantation Rocks, Buoy Rock, Potter's Rock, Slatestone Flat Rock, Dog Fish Bed, Drum Bay Point Bed, Trevise's Bed, Shell Bed, Buoy Spit Bed, Muddy Marsh Bed, Bird Bed, Hern Island Bed, Beach Island Bed, Parker's Bed, and Brig Bed.

In considering and describing the beds I shall separate the first ten from the others, and, as they are subjected to very similar conditions of bottom, current, and density of water, shall treat them under one head, as the Pocomoke beds.

SCATTERED OYSTERS IN POCOMOKE SOUND.

The area covered by scattered oysters is determined only approximately, it being very difficult to accurately define the limits. Generally speaking, the one-fathom curve will nearly mark the inshore limit, while the soft muddy bottom of the main channel will define the outer one. The depth of water over the scattered oysters and the character of the bottom can be ascertained by reference to the chart. No oysters were found in the deep channels nor on the shoal sand-spits.

The oysters are scattered singly and in groups, but usually grow singly, though numbers of small beds of a few hundred yards area are included within the limits of scattered oysters. In the vicinity of the Messongo and Guilford Creeks the oysters seem to be scattered in that manner, the spaces between the groups being proportional to their sizes. Very few oysters were found along the edge of the shoal on the western side of the channel south of the Muddy Marsh. In the channel itself no oysters were found. Opposite Beach Island, in from thirteen to fourteen fathoms, a few clams and shells were brought up. In this case, however, the bottom was of hard sand. The area covered, to a greater or less extent, by the scattered oysters comprises 122,117,000 square yards, or 29.60 square nautical miles. The number of oysters over this area, as nearly as I could ascertain, was about 0.12 to the square yard.

Pocomoke Beds.—Across the mouth of the Pocomoke River lie the "Old Rocks," comprising an area of 1,057,000 square yards, and marking the limit to which the oysters of the Sound extend, only few small rocks being found in the river. Below the "Old Rocks," on the western side of the

channel, are the Buoy Bed, comprising three "rocks" and 967,000 square yards; Potter's Bed, of seven "rocks" and 900,000 square yards; Dog Fish Bed, of 720,000 square yards; Flat Bed, of 742,000 square yards, and Trevise's Bed, of 697,000 square yards.

On the southern side of the channel, and extending from it to the sands, are the Old Plantation Bed, of 180,000 square yards; the Slatestone Bed, of 967,000 square yards; the Drum Bay Point Bed, of 337,000 square yards, and the Shell Bed, comprising five "rocks" and an area of 1,102,000 square yards.

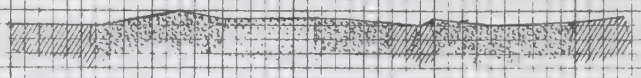
The depth of water over the beds can be seen and studied by referring to the chart. The average depth is from 8 to 12 feet at low and from 11 to 15 feet at high water, the deeper water being found near the channel and over the mud sloughs. Of the different beds the "Old Rocks," New Plantation, and Buoy are in the shoalest water, and the Shell Bed in the deepest. The channel has 27 feet off the Shell Bed, and shoals gradually to 10 and 11 feet off the Buoy Bed. None of the beds are solid or unbroken; those approximating to that condition are the "Old Rocks," New Plantation, Buoy, and Slatestone Beds. The majority of the beds have been cut up by the dredges or mud sloughs into small groups and ridges, with oysters scattered between them. The divisions, however, are too small to be shown on the chart.

The bottom generally consists of mud, and the stratum is both softer and thicker in the vicinity of the channel than elsewhere. On the beds remote from the channel hard bottom was occasionally found, and near the one-fathom curve sand and gravel; the last character of bottom was sometimes found in deep water, but not frequently, except about Trevise's Bed and near the sand shoal, to the southward and westward of Ape's Hole Creek. Between that creek and Meremscot Creek, to the eastward, the bottom is a mixture of sand and clay, and the locality is therefore a favorite planting ground, as is Ape's Hole Creek and the light above the "Old Rocks." On the Old Rocks we found the surface stratum of shells, oysters, and mud to be about one foot thick and the substratum of soft sand or mud. In the vicinity of the bed the bottom is similar, except that the substratum is of shell. On the New Plantation Bed the surface stratum was of sand and shell, 3 feet in thickness, and the substratum hard sand. The Buoy Bed has a light covering of mud and fine sand on the shells and oysters, and a substratum of hard sand and shell. In the vicinity of the bed the bottom is soft mud. On Potter's Bed the surface stratum was of sand and shell, 1 foot thick, over a stratum of soft mud. In one case on the "rock" most remote from the channel the substratum was hard sand. Within the area north of Potter's Bed, occupied by scattered oysters, the bottom, with one exception, was of mud over a stratum of hard sand. On the Slatestone Bed the surface stratum is of mud and shells, from 1 to 5 feet in thickness, over a stratum of sand, or sand and clay. On the Dog Fish and Flat Beds we found a surface stratum of sand, mud, shells, and oysters 2 or 3 feet thick, and underneath that a hard stratum. About these two beds there are several places where the substratum was a mixture of sand and clay, similar to the bottom of the planting grounds. About and inshore of the Drum Bay Point Bed the bottom was of sand and gravel on the surface, with clay or sand and gravel underneath. The probe was not used on this bed nor on Trevise's Bed, but about the latter the bottom is of soft sand for a few feet and then hard sand. South of Trevise's Bed, near the channel, the bottom is of mud. The Shell Bed derives its name from the character of its bottom, which consists of a stratum of shells about 1½ feet thick, over a stratum of mud of from 1 to 4 feet in thickness, after which the bottom appears to be hard. In the vicinity of the bed the bottom is of sand, which becomes harder as the distance from the bed increases and the water shoals. In the channel the bottom is soft mud, and no oysters were found in it.

Within the lines defining the limits of the scattered oysters the animals are distributed, but very unevenly so. Even on the beds the distribution is by no means regular, or likely to become so, the production and growth of the oysters varying with the locality, and the size, contour, and character of each bed continually changing from the action of natural causes and the constant fishing. Throughout the area assigned to scattered oysters, many small lumps and patches may be found; but generally the oysters are scattered in small clusters or singly, and those on the beds are of the same general character, being small, single, or in clusters of two or three, and without parasites or parasitic attachments. There was a remarkable absence of young oysters of less than six months' growth, even, as in the case of the Shell Bed, where the bottom was clean and shelly,

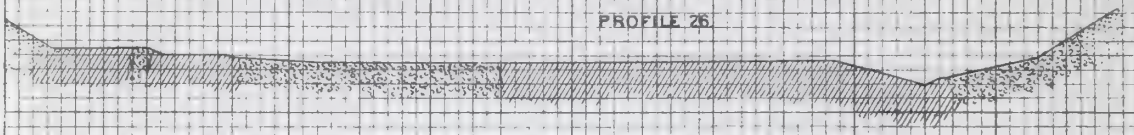
DIAGRAM 7.

PROFILE 25.



ACROSS POTTERS BED

PROFILE 26.

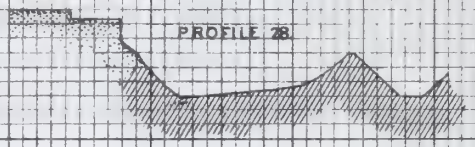


ACROSS UPPER PART POCOMOKE SOUND

PROFILE 27.

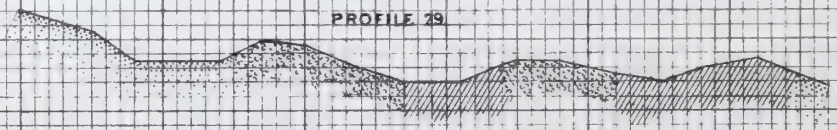
ACROSS SHELL BED

PROFILE 28.



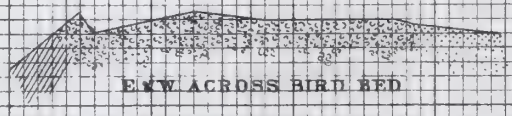
ACROSS BUOY SPIT & MUDDY MARSH

PROFILE 29.



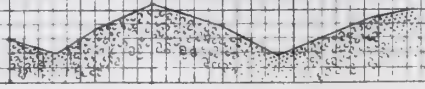
N & S ACROSS BIRD BED & HERN ISLAND BED

PROFILE 30.



E & W ACROSS BIRD BED

PROFILE 31. E & W ACROSS HERN ISLAND BED



and apparently in good condition for attachment. Generally the mature oysters were scarce, though many shells were found, and on the Shell Bed the number to the square yard was as small as 0.015, though great quantities of broken shells were brought up. The Slatestone and Drum Bay Point Beds appeared to be in best condition, so far as to the number of oysters.

Buoy Spit Bed.—This bed lies on the eastern side of the channel, southwest of the Shell Bed and opposite the Muddy Marsh Bed. Its area is 427,000 square yards. It extends NNW. and SSE. five-eighths of a mile, and has an average breadth of one-quarter mile. The depth of water over it is from 14 to 19 feet, the shoal water being found on the southern part of the bed and the deep water on the northern part, and near the channel. The bed is comparatively unbroken, except about the edges, where the oysters grow in groups separated by mud sloughs. Apparently the bed is very old, the stratum of shells being very thick. The oysters are evenly distributed over the entire area. The bottom consists of a stratum of shells, oysters, and mud, about 3 feet thick, over a stratum of hard sand and shell; on the southern part of the bed the substratum is mud. In the vicinity of the bed the bottom is soft sand or mud, the latter being found in the channel. The oysters were single, with very few young attached; a moderate amount of red sponge was found. No oysters existed in the channel. Those scattered near the bed were to the eastward. They were similar in character to those on the bed, but a larger number of young were found, and about one-third of them had been injured by the drills.

Muddy Marsh Bed.—This bed is on the western side of the channel, opposite the Buoy Spit Bed, and comprises an area of 1,912,000 square yards. The main bed is long and narrow, extending 2½ miles along the edge of the channel, and being on an average about one-quarter of a mile broad. One-half mile to the northward of the main bed are two detached "rocks," whose area has been included in that just given. The depth of water over the bed, as will be seen by the chart, is from 11 to 17 feet; the small "rocks" have from 13 to 14 feet over them. The shoalest water found was about the central portion of the principal bed, and the ridge marks, approximately, the original oyster "rock." From this ridge the water deepens slightly to the westward and considerably to the eastward. The bed is comparatively solid, having few mud or sand sloughs in it; about the shoal ridge it is entirely unbroken. The oysters are spread unevenly over the entire area, the smallest number being found on the shoal, unbroken, central part, and the largest number about the extreme ends of the bed, where the water was deeper and the bottom softer. On the small beds to the northward the oysters were scarce, and many clams were found. The bottom on the two detached "rocks" consists of a stratum of shells and mud over a stratum of mud. To the southward, and between them and the main bed, the bottom is of hard sand and broken shells. Where the beds approach the channel the bottom is softer, and in the channel only soft mud is found. A few mud sloughs and mud patches were discovered at some distance from the channel, but generally the surrounding bottoms are hard. On the main bed a very thick and hard stratum of shells, with a little sand on the surface, composes the bottom. We could drive the probe down some 2 or 3 feet, but did not in any case penetrate the shell stratum, except on the southern portion, where the bottom is neither so hard nor so shelly as about the center of the bed. South and west of the bed the bottom is sandy, and hardens as the water shoals. A few mud sloughs were found along the western edge of the bed, but it is noticeable that on the principal part of the bed there was little or no mud, and that the bottom was fairly clean. The oysters on the bed and from its vicinity were of medium size and fair quality, single, and very scarce. Very few young, no young growth nor drills, and no sponge, grass, or parasitic attachments of any kind were found, but an immense amount of broken shell and other *débris* was brought up by each haul of the dredge. On one occasion the dredge filled in three minutes; shells and one oyster resulted. A similar haul produced a dredge full of shells and five oysters. As the dredge held about two bushels, the percentage of *débris* is thus shown to be enormous. The hauls were made on the shoal, solid portion of the bed, where, according to most experience, the oysters should have been most numerous. The number of oysters to the square yard, from observations in these places, was 0.40.

The Bird Bed.—This bed lies on the eastern side of the main channel and across the channel into Messongo Creek. It is irregular in shape, and is the largest bed in Pocomoke Sound, having an area of 3,285,000 square yards. The southern extremity joins the Hern Island Bed, thus

practically making the two beds one; but as the oysters were not very thick in the channel into Guilford Creek, the original dividing space, and as the two beds still retain their original names, I have considered them separately. The depth of water over the Bird Bed is from 14 to 24 feet, the deep water being found near the channel and the shoal near the sand spits. The bed is unbroken, except about the edges; that portion indicated on the chart by the dark line is less broken than the remainder, and probably in that vicinity was located the original "rock" from which the bed has extended. About the western edge the bed is broken by mud sloughs, and immediately to the eastward of the bed numerous small, detached groups of oysters are found and a few small beds, whose area has been included in that given for the Bird Bed. The oysters, though found over the entire area, are not evenly distributed, but exist in larger numbers on the northern and more solid portion of the bed than elsewhere. The bottom is hard, of shells, with a light covering of mud. On the western portion the substratum was of mud, but elsewhere it was generally hard, probably of sand. To the northward of the bed the bottom was of sand, soft on top and hard underneath; to the south and west soft mud was found. The oysters were single, of medium size, and good quality. No sponge or grass was found, but many old and broken shells. In the vicinity of the muddy bottoms the shells were black and no young were discovered, but on the central part of the main bed, where the shells were of ordinary color and moderately clean, large numbers of young were found. It was noticed that many of the young had been destroyed by the drills, and especially about the solid portion of the bed, where as many as 152 out of 156 on one shell had suffered. As the channel was approached the drills (*astyris*) did not appear to be as numerous nor to have done as much damage, only about one-fourth of the young having been destroyed. The number of oysters to the square yard, the mean of four observations on different parts of the bed, was 0.36.

Hern Island Bed.—Originally this bed was south of the channel into Guilford Creek, but by the action of natural causes and by dredging it has been extended across that channel and connected with the Bird Bed. It lies due south of that bed and extends in an east and west direction one mile, and has a width of about one-half mile. Its area is 2,092,000 square yards, and it is next in size to the Bird Bed. The depth of water is from 14 to 22 feet, the shoal water lying a little to the westward of the central portion of the bed, and the deep water being found in the Guilford Channel. The bed is broken about the edges, especially the northwestern one, and where it borders on the Guilford Channel, but elsewhere and in the center it is comparatively solid. A few mud or soft sand spaces were found in the eastern part. The oysters are distributed very evenly over the entire area. The bottom generally is hard, of shells and sand, though only a small amount of the latter was found. In the Guilford Channel and its vicinity the bottom is softer and the substratum of mud. To the southward of the bed hard sand is found, and in the channel to the westward the usual soft mud. The oysters were single, small, and principally of a young growth. Those adult oysters taken by us were of fair quality. Many old broken shells were brought up by the dredge but no sponge or grass. Many young were discovered and a large number, over 25 per cent., had been destroyed by drills. Large numbers of *astyris* were present with the young. The number of oysters to the square yard, the mean of six observations, was 0.29.

Beds of the Guilford Channel.—South of the Guilford Flats, on each side of the channel into Guilford Creek, are two narrow ledges of oysters, extending east and west and following the trend of the channel. The northern bed is 1 mile in length, and has its greatest width, of one-third of a mile, at its eastern extremity, and its least, of one-tenth of a mile, at its western. Its area is 585,000 square yards. The southern bed is $1\frac{3}{4}$ miles long, one-quarter of a mile broad at its western and one-tenth of a mile at its eastern extremity. Its area is 630,000 square yards. The northern bed has an average depth of water over it of 11 feet. The southern has from 9 to 21 feet, the deeper water being on the extreme western part of the bed. Both beds, though narrow, are solid, being but little broken even about the edges. They are old and not frequently worked. The bottom is of mud and shells for several feet, and underneath that a hard stratum. The oysters were scarce, and no young were found.

Beach Island Bed.—This is a small Bed, lying about 1 mile NNE. of Beach Island, and south of the narrow channel into Deep Creek. It is irregular in shape and comprises an area of 225,000 square yards. The depth of water over it is from 12 to 17 feet. The bottom is of mud and shells,

the stratum being about 3 feet thick on the southern border and increasing in thickness as the channel is approached. Where it could be ascertained the substratum was found to be hard, and is, probably, of sand, as the bottom contiguous is of that description. It is probable that narrow ledges of oysters exist on both sides of the Deep Creek Channel, above Beach Island, but lack of time prevented our verifying the supposition. The bed is unbroken, and the oysters single and presenting the same general characteristics as on the beds already described. A moderate number of young was found, and the presence and destructive effects of the drills were noticed.

Parker's Bed.—This is a small bed lying east of Watts' Island, and on the western side of the channel into Pocomoke Sound. It is long and narrow, extends north and south five-eighths of a mile, and has an average width of one-fifth of a mile. The depth of water is from 12 to 24 feet, the shoal water being found about the middle of the bed and the deepest water on the southeastern portion. The bed is unbroken except about the edges, and the oysters are spread uniformly over the area, which comprises 495,000 square yards. The bottom is hard and consists of a stratum, 3 feet thick, of shells and mud, over a stratum of hard sand or clay. The contiguous bottoms are of soft sand or mud, with a hard substratum. The oysters were single, of moderate size, and similar in quality to those on the other beds of the Sound. They were not numerous, the number to the square yard being 0.57, but that number is larger than on any of the other beds in Pocomoke. Some of the red sponge was found, but nothing else. Large numbers of young and drills (*astyris*) were discovered, but for some reason the drills appeared to have been less destructive than elsewhere. Those oysters found near the bed were larger than those on it, but had no young attached to them.

The Brig Bed.—This bed lies to the northward and westward and off the mouth of Chesconnessex Creek. It is small, nearly oval in shape, and comprises an area of 517,000 square yards. Its extent east and west is five-eighths of a mile and its greatest width, north and south, is three-tenths of a mile. The depth of water is from 19 feet on the eastern edge to 48 feet on the western. The bed is unbroken, except about the edges, where the oysters are somewhat scattered; on the solid portions they are not very evenly distributed, being more numerous about the center of the bed than elsewhere. The bottom is hard, and probably of sand and shells, but, owing to the depth of water, it was impossible to use the probe successfully; the contiguous bottoms are, however, of the character described, and it is probable that there is no difference on the bed. The oysters were large and single and of superior quality to any on the other beds. A moderate number of young and a few drills were found, but no sponge or grass, though some of the latter was discovered among the scattered oysters. The number to the square yard was 0.27.

DENSITIES.

The density of the water on the different beds was obtained in the same manner as in Tangier Sound.

The least density found, that of 1.0113, was across the mouth of the Pocomoke River at low water of the spring tide. The water of the greatest density, that of 1.0174, was taken from about the middle of the Sound, over the Bird, Buoy Spit, Muddy Marsh, and Hern Island Rocks. The density over the beds, therefore, would be within those limits, the variation amounting to 0.0061.

The effect of the tide does not appear to be invariable, as the greater densities were found as frequently on the ebb tide as on the flood. The depth of water and the prevailing winds have probably a greater effect than anything else, as the density increases with the depth, and the prevalence of easterly or southeasterly winds, backing the waters of the bay up into the Sound, would have a like effect. As the variation noticeable during the space of eleven days, under various conditions of weather, was so small, it can hardly be much greater at any time, and unless much greater than shown by the records, and if representing the change in salinity, it can have but very little, if any, effect upon the oysters on the beds. By the following tables of comparison it will be seen that the fluctuation of density is, as in Tangier Sound, greatest at the head of the Sound and least at its entrance, with an increased fluctuation where the influence of the Mesongo and Guilford Creeks is felt.

On the beds above the Bird Rock the difference of density noticed was 0.0061. On the remainder of the beds the difference was 0.0015, showing that there is a much smaller change in the density over the southern beds than over the northern.

Comparison of densites—Pocomoke.

[The figures show the excess of density over that of distilled water, which is represented by 1,000.]

Bed.	Maximum density.	Tide.	Remarks.	Difference.	Minimum density.	Tide.	Remarks.
On and above Potter's and Slatestone.	1.0160	High water and one-quarter ebb.	.....	.0047	1.0113	Low water	Section.
Shell Bed and above ...	1.0170	One-quarter flood ..	14 feet; calms and light breezes several days.	.0014	1.0156	Three-quarters flood.	5 feet.
Muddy Marsh.....	1.0174	Three-quarters ebb	18 feet and same as above	.0014	1.0160	One-quarter flood ...	Strong easterly breezes.
Buoy Spit	1.0172	One-half flood.....	15 feet and same as above	.0004	1.0168	One-half ebb.....	15 feet; light breezes.
Bird and Hern Island Beds.	1.0175	One half ebb	4 fathoms and same as above.	.0015	1.0160	Three-quarters ebb .	18 feet; mouth of Guilford Creek.
Mesongo Creek.....	1.0173	One-half ebb	17 feet and same as above	.0007	1.0164	Low water	Eastward station, 7 feet.
Guilford Creek	1.0167	High water	9 feet; light breezes ...	.0007	1.0160	One-half flood.....	Head of creek.
Parker's..... ..	1.0172	One-quarter ebb ..	12 feet; light breezes ...	.0009	1.0163	One-half flood	Light breezes.
Brig.....	1.0169	Three-quarters flood.	11 feet; light breezes ..	.0005	1.0164	Low water	17 feet; light breezes.

CURRENTS.

Over the Pocomoke beds the general set of the ebb current is westerly until it reaches the shoal between and south of Broad and Ape's Hole Creeks, where it turns to the southward into the main channel. The majority of the observations of the ebb current were made during moderate northeasterly breezes, but the direction seems to have been but little influenced by them, though the strength probably was; as at high and low water by the tide tables, when there should have been no perceptible current, one was observed of from 0.1 to 0.2 of a mile an hour. The maximum strength observed was 0.5 of a mile per hour. The flood current sets northeast over the beds, and has a maximum strength of 0.5 of a mile per hour, and is but very slightly influenced in direction by the wind.

In the main channel of the Sound, below the Shell Rocks and over the Muddy Marsh Rocks the flood current sets to the northward, following the general direction of the channel. The maximum strength of this current, when uninfluenced by the wind, was 0.45 of a mile per hour. No observations of the strength of the ebb current were made in the main channel; but it is probably equal, or of slightly greater strength, than the flood, and sets to the southward.

Over the Bird and Hern Island Rocks the flood current sets to the northward and eastward into Mesongo and Guilford Creeks, with a maximum velocity, when uninfluenced by the wind, of 0.24 of a mile per hour. The ebb sets to the southward and westward, curving to the southward as it becomes influenced by the main current, with a maximum velocity of 0.4 of a mile per hour.

North of the Guilford Flats the flood sets northeasterly toward Muddy Creek. The maximum velocity observed during light northerly breezes was 0.3 of a mile per hour. South of the Guilford Flats the current follows the general direction of the channel, the flood having a tendency towards Hunting Creek, where the channel into Guilford Creek joins the latter. The maximum velocity observed during light northerly breezes was 0.5 of a mile per hour.

The ebb out of Mesongo and Guilford Creeks sets to the southward and westward, following the channel until it reaches the Bird and Hern Island Beds, where it curves to the southward. Its maximum velocity was 0.4 of a mile per hour. The current over the Brig and Parker's Beds sets to the northward and to the southward; the maximum strength of the flood, when uninfluenced by the wind, was 0.24 of a mile per hour, but a moderate breeze appears to be sufficient to cause a marked increase of strength and change of direction. Off the mouth of the Chesconessex, where the wind, though light, had the width of Chesapeake Bay and both Tangier and Pocomoke Sounds to sweep over, the flood tide on the third quarter had a set to the northward and eastward of 0.4

of a mile per hour. North of Parker's Bed the flood, on the first quarter, during a moderate southwesterly breeze, was found to set to the northeast at a rate of 0.6 of a mile per hour.

The oystermen greatly overrate the strength of the currents in the Sounds, putting the maximum velocity at about four knots on the ebb and somewhat less on the flood; but I could find no reason that would explain so great an increase over the velocities as established by ourselves, and consequently doubt the value of the estimate.

DEPOSITS.

The fact that on nearly all the beds, and especially those in the vicinity of the creeks and rivers and in the upper part of the Sound, there is a light covering of mud, more or less thick, over the oysters, would lead to an inference that there must be a deposit of that character going on. On most of the beds the substratum of the bottom was hard and the thickness of the surface-covering gradually decreased as the entrance to the Sound was approached. In the upper part of the Sound shells were found with the mud for several feet, and of such a number and character, being old and discolored, as to forbid the supposition that they had recently sunk in the mud or been covered by it.

The Pocomoke River, draining an extensive tract of the Peninsula, would bring down a large amount of sediment, which the strong ebb current would carry directly over the beds in the upper part of the Sound. The set of the ebb is east, and, as will be seen by the chart, the deeper water lies nearest the southern shore of the upper Sound, and those beds lying to the southward of the channel are the hardest and least broken. The shores are low and marshy, and probably add somewhat to any sediment held by the main current before it enters the Sound.

I infer that there is a deposit going on of maximum amount over the Old Rocks and those to the northward of the channel, and decreasing as the entrance to the Sound is approached. The amount in any given period of time would be difficult to ascertain, but the character will be shown to some extent by an examination of the specimens of bottom. Whether the amount of matter deposited is sufficient in quantity to seriously affect the beds is a matter of conjecture; I should judge that it was not, and my opinion coincides with that of all the oystermen I was able to interrogate. That it must have some effect cannot be doubted, and the evident deterioration of the beds in Pocomoke Sound may be accounted for, to some extent, by the supposition that the effect is injurious; but so many other and more direct causes exist for the deterioration that it is difficult to eliminate their influence. The fact that the beds have existed and have been worked since the first settlement of the country would lead to an inference that the effect, if prejudicial, was very slightly so.

The scattered oysters lying on the sands and those beds in the vicinity of sand-shoals and in shallow water, the Muddy Marsh and Beach Island Rocks particularly, are exposed to damage by "sanding" in a manner similar to certain beds in Tangier Sound, and which has already been described. The large amount of grass, sponge, and sea-weed growing on the sand shoals, especially the one to the east of Hern Island and south of the Guilford Channel, is frequently torn up by the heavy gales and deposited on the beds with the same injurious effect that it had in Tangier Sound. Heavy southerly gales will sometimes cover the beds above the Buoy Spit and Shell Beds with mud for a short time, but not sufficiently long, it is said, to affect the oysters seriously.

EFFECT OF ICE AND GALES.

The heavy gales that occur in winter and summer, though principally during the former season, increase or diminish the depth of water on the beds sometimes as much as three feet. Strong northerly and northwesterly gales have the effect of diminishing the depth of water, piling up any floating ice upon the leeward shores, and cutting away parts of those shores. Heavy southeasterly and southerly gales will increase the depth of water on the beds, stir up the soft muddy bottom of the channels and beds above Shell Rock; and, during the winter, in addition to piling the ice on the leeward shores and planted beds near Ape's Hole Creek, will pile it up on the Old Rocks, Buoy Rock, and Shell Rocks. Generally speaking, the beds in this, as in Tangier Sound, are in too much water to permit their being uncovered by even the heaviest gales, or to allow the

ice to ground upon them at any time; but those beds in shoal water (of about one fathom), and the planted beds, which are generally in less, are subjected to both evils. The effect of gales and ice in Pocomoke Sound seems to be less than that in Tangier Sound, in consequence of its less extent and smaller area.

GENERAL INFORMATION GIVEN BY OYSTERMEN.

The following information is that derived from the answers to the questions propounded to the fishermen and others.

All the oystermen and dealers that were encountered during the season, so far as was possible, were interrogated. That which was not pertinent to the subject, or evidently influenced by self-interest or other considerations, has been excluded.

There has been no material change of the channel within the memory of the oldest fishermen, nor have they ever found oysters in the deep water of the main channels of either Sound. With regard to the improvement or deterioration of the beds, it was the general opinion that the beds had been much extended in size, that the quality of the oysters had improved, both as to size and flavor, but that the number on the beds had been very materially diminished, so much so, that it was hardly profitable to work on some of the beds. About thirty years back, the large beds in the Sound were not known to the fishermen and when first discovered and worked, the oysters were in clusters, long and thin valved and of poor quality, though very numerous and easily taken. Since their discovery, and especially during the last ten years, the beds have been greatly overworked and the number of oysters much lessened.

Formerly, the best oysters were found on the Terrapin Sands, and there were none on the sands inshore of the beds; now the finest oysters in the Sounds are found on the sands bordering on the beds and are considered better than any in the general market. All the beds have been much extended by dredging, especially the Bird Rock in Pocomoke Sound and the Great Rock in Tangier Sound, the former being two-thirds larger than when first discovered, and the three rocks, of which Great Rock was originally composed, having been dragged into one continuous bed. Though thus extended, it was the opinion that there were not as many oysters on the beds at present as were found on the smaller areas. In Fishing Bay, at the northern extreme of Tangier Sound, though the beds as a whole had deteriorated, during the last four years there had been some improvement on account of a more rigid observance of "close time."

The cause assigned for the deterioration, and even the admittance of the fact, depended very much upon the occupation of the informant. The tongers, or those who pursued the fishery with tongs alone, were unanimous in laying the deterioration to excessive dredging, while the dredgers, or those owning pungies or other vessels employed exclusively with the dredge, while they admitted the decrease in the number of oysters, laid such decrease to the action of natural and unexplained causes, arguing that the evident extension of the beds and improvement of the oysters, due to dredging, was sufficient to prove its good rather than ill effects.

With regard to the effect of ice in cold weather, every one coincided in the opinion that the oysters in deep water were most affected and those in shoal or brackish water were least so. In the same depths and character of water, those oysters about the edges of "muddy rocks" and close to muddy channels or sloughs were most affected by the cold or a severe freeze. After the latter event the packers distinguish the deep water oyster by its dark, slimy appearance, and decline it, though at the same time shoal-water oysters are in good order and are accepted. With regard to the quality of the animals, those in the Sounds were considered finer than those in the creeks and rivers, and of the different beds those from the Shark's Fin, Terrapin Sands, and Bird Beds were considered superior. Regarding flavor alone, those from the salt water were the best, and generally the salter the water the better the flavor.

With regard to an increased freshness of water, due to freshets and heavy rains, it was the general opinion that during the winter season it was not of much consequence, but that in spring or summer heavy rains or freshets were very beneficial, especially in the spawning season, hastening its advent and shortening its duration. An increased freshness of water always fattened the oysters. Oysters in salt water were always poor, and oysters were generally poorer after a dry

season. Planted oysters above Pig Point and the Old Rocks, in Pocomoke Sound, have been known to die from absorbing too much fresh water, and those on the Old Rocks have sometimes suffered from the same cause; but this only occurs during heavy freshets.

With regard to the depth of water and character of bottom, shallow water was preferred, and sticky mud or mud and sand, about six inches in thickness over a hard substratum, was considered the best, though a larger amount of mud did not matter, provided it was not so soft as to allow the oysters to sink in it and had a strong current over it.

The oysters were said to feed on the flood tide, having their bills open then and at no other time. No one had noticed any enemies or animals that preyed upon the oysters, and all seemed to be ignorant of the drills and their destructive effects.

The oysters are "culled," that is, they are separated from the old shells and other *débris*, while the boat or vessel is on or near the bed. Everything except the oysters is thrown back, sometimes striking the bed and as often the mud. The young oysters under a year and a half in growth and less than two inches long are also thrown back.

All persons interrogated were of the opinion that at least 75 per cent. of the oysters on a bed are taken off each year, and that no more than 50 per cent. should be removed. Off the beds near Haine's Point, at least 100,000 bushels, or about 20,000,000 oysters, were taken in the season of 1878. Off the Great Rock, about 100,000 bushels, were taken by one hundred boats in October and November of 1877. The oysters on the rock at the end of November were so scarce that but a very small number of boats could find profitable work on the bed. In the spring about 75,000 bushels more were taken up and sent north, and as the oysters were small, they amounted to probably 15,000,000 at least. Exclusive, then, of the fishing done during the winter months, in one season it is estimated that 30,000,000 of oysters were removed from one bed alone.

Nearly all the oystermen advocated a "close time," either from April 1 or May 1 to October 1; many considered a prolongation until November 1, and an entire rest every other year, would be beneficial.

With regard to transplanting the oyster and its transportation, all experienced persons were of the opinion that delicacy of handling, and freedom from jars, concussions, and shocks of any kind were desirable. Oysters when under hatches have very frequently been killed by heavy thunder storms and firing of guns. Any concussion or sudden shock will prove destructive if the animals are in a confined space. Oysters taken up during the summer are much more susceptible to injury from this cause than those obtained during the winter.

Oysters are transplanted at any and all seasons, but generally in the spring and autumn. Oysters obtained by the use of the "tongs" are preferred to those dredged, and generally those taken either before or after the spawning season are most desirable. The dredged oysters are apt to be broken about the bills and will die on the planting grounds sooner and in larger numbers than the "tonged" ones. Those oysters planted about the Sounds are generally obtained from "tongers," but those sent to the north, being in such large numbers, are usually dredged. The size and age of the oysters to be transplanted depend on whether they are for early consumption or not. If the former, the larger and older the better, but in the latter case young oysters, from one to two years old, are preferred. Generally any and all oysters are taken, without regard to age or size. The oysters for the northern planting grounds are usually taken up as soon as ice clears away and are used during the spring. Those transplanted in the Sound are taken up later in the spring, or during the early summer or autumn months, and used during the following winter. Blunt-nosed oysters, with thick shells, do not thrive on the planting grounds. A change of bottom in transplanting oysters is not considered of so much importance as a change of water. The planted beds should be laid at the mouths of creeks and rivers having a rapid current. The bottom best for natural beds was considered best for planted ones.

The spawning season was said to be from May until August, inclusive, though most of the spawning was done in June and July. All opinions coincided that the oyster in shoal water spawned first, but differed as to whether, the depth being the same, all oysters on the same bed spawned at or about the same time, as many being for as against the theory. Currents were said to have no effect upon the spawning. Oysters of one year's growth, three-fourths of an inch long, have been seen with the spawn in them, and oysters on natural beds were thought by the majority

to spawn sooner than the planted ones, though there was not much difference. Oysters transplanted with the spawn in them, however, will cease spawning. A wet or warm spring would hasten the time of spawning, but would not shorten its duration. Heavy freshets were very destructive to the "spat" in Pocomoke Sound, driving it out into the bay, and large schools of fish, especially trout and tailors, devoured a good many every spring and summer. The young were supposed to "strike" every three years, though there was but little regularity about it, a bed sometimes running for ten years with a young growth on it every year and then failing to produce anything for two or three years. Sometimes one part of the bed will be covered by young, and another part totally barren.

No systematic attempt had ever been made to increase the amount of "cultch" in the Sounds, though a few persons had placed old shells, ballast, boards, and boughs about their planting ground and succeeded in making a good catch. It was the general opinion that the oyster increased in size from one to two inches in the first year of growth and a little more than that during the second; afterwards the increase was much less. Oysters from two to four years old were considered as best for the market, and are then from 3 to 4 inches long.

Ten bushels of oysters were considered a profitable day's work for a tonger. For a dredger the number of bushels varied on account of their different sizes. About 60 bushels were considered a profitable day's work for the larger vessels and from 20 to 30 for smaller craft. The dredging vessels employ from four to nine men, and the "tonging" canoes one man and a boy. Tonging could not be carried on profitably in depths greater than 4 fathoms in the Sound, and dredging in not more than 6. The dredges vary in size, from 2 to 4 feet across the mouth, with from eight to sixteen teeth. Generally they are made about 3 feet wide, with twelve or fourteen teeth, but vary a good deal in weight. My informant found that, generally speaking, it was more profitable to fish with the tongs exclusively, for the large oysters used for barreling by the dealers, and to dredge for packing and canning establishments. The tongs are worked at small expense and the "barrel" oysters bring a much larger price, though they are necessarily selected oysters and more difficult to obtain. The prices paid during the season of 1877–'78 were about $1 per barrel for "barrel" oysters and from 5 to 40 cents for the ordinary oysters from the beds; the "snaps," or most inferior quality, bringing the lowest price, and 40 cents being paid only for "extra culled" oysters. About 20 cents per bushel would allow a small profit. The flavor is not generally taken into account, and the degree of fatness and the size settle the price. Salt-water oysters sometimes command better prices when intended for a special market or to supply some unusual demand.

With the improved appliances in use, as at present, the general opinion was that about twenty or twenty-five years ago one-third more oysters could have been taken in the northern part of Tangier Sound than at present, from two to five times as many about Crisfield, and in Pocomoke Sound nearly seven times as many as at the present day; that without any of the modern contrivances it was possible then for either tongers or dredgers to take many more in a day than at present. The general opinion of all persons in and about the Sounds, with a very few exceptions, was that the beds were being worked much beyond their capacity, and the majority were in favor of extending the "close time" as a remedy for the deterioration. Many thought that a resting time of a year or more would be beneficial. All were in favor of enforcing the law prohibiting the dredging and working of the beds during the "close time," and all testified that there was no attempt toward the enforcement of the law at present, either by the oyster police or any one else.

CONCLUSIONS.

The foregoing pages, with the record and charts, contain all the data collected during the season for the study of the beds and the conditions affecting the animals upon them. Not regarding it as within my province and not possessing sufficient knowledge of the subject, I have not attempted any study of the biology of the oyster, but have confined my report to as concise a description as possible of the beds and conditions surrounding the various forms of life upon them. The following remarks are simply the conclusions drawn from certain peculiar features and facts established by the investigation and testimony and an attempt to account for them.

In reviewing the remarks upon the different beds, it will be seen that there is a marked absence of oysters classed as "young," or those supposed to be of the last brood, on all beds above Kedge's

Strait in Tangier Sound, and above the Bird Rock in Pocomoke Sound. In Tangier, the young first appeared in considerable quantities on the middle of Muscle Hole Bed and Piney Island Bar. There were none in either the Manokin or Big Annemessex Rivers or on the northern part of Harris' Rock, though large numbers were found on the central and southern portions of the latter. The southern beds of both Sounds were plentifully supplied. Again, on the southern beds there was an absence of the class termed by us "young growth," or oysters apparently spawned during the previous season, while on the northern beds of both Sounds the proportion of this class was very large. Over these different beds the change of density is too slight to enter into the question and the currents too nearly similar, both in direction and strength, to have influenced the difference in production. On nearly all of the northern beds in both Sounds the bottom is muddy or the beds in close proximity to muddy bottoms. To the southward, however, the bottom is hard and the beds surrounded by sand or gravel, except on the edges nearest the channels. Again, all the northern beds in both Sounds are in comparatively shoal water and those in the southern parts in deep water.

There are, then, two similar facts noticed in both Sounds with regard to the presence and absence of the young and "young growth"; the former have been found in deep water and on hard bottoms, the latter in shoal water, on or near soft bottoms. The character of the bottom can hardly be of much importance in this case, for though a hard, clean bottom is necessary for a successful attachment of the "spat," yet the bottoms on the northern part of the Sounds must be sufficiently so to obtain a large quantity, as is shown by the large number of young growth on those beds; and that the absence of the young is not due entirely to that cause is shown by their scarcity on the Chain Shoal and Drumming Shoal Beds in Tangier, and Shell and Muddy Marsh Beds in Pocomoke Sound, where the bottom is hard and moderately clean. Remaining, then, as the only probable cause known to us, is the difference of depth of water.

It will be found upon reviewing the remarks and record that almost invariably the young are found in deep water and the young growth in shoal. It was the opinion of the oystermen that the oysters in the Sounds increased from one to three inches in length in the first year of their existence. The class termed "young growth" by us were from three-fourths of an inch to one and a half inches long; and supposing the oystermen to be correct in their estimation of increase in size, the class termed "young growth" would then be of the same season's brood, spawned much earlier than those termed young. The investigation of the beds was carried on in September, and in Tangier Sound the principal amount of information was collected during the latter part of that month and the first part of October. If, then, the oysters on the shoal-water beds had spawned in the early part of June, they would have had about four months growth when our observations were made. In searching for spawn in the oysters during the latter part of August and first part of September, Mr. Rice was unable to discover any except in those from deep water, and that fact, together with the inference drawn from the preceding paragraphs, leads me to believe the oystermen correct in stating that there is a difference in the time of spawning of the shoal and deep water oysters. There is but one other way of accounting for the absence of young on the northern beds, and that is by accepting the supposition that the "spatting" not only does not occur every year, but that it occurs only on parts of the Sounds during each season. Such is the opinion of many people of experience, but I am inclined, from the results already given, to prefer the other solution of the problem, not having found any reason that would support the opposite theory or lead to its entertainment.* The difference in time of spawning in shoal and deep water is probably due to difference in temperature, the deeper water naturally being of the lowest. The establishment or the refutation of this supposition, as also of that of the difference of the times of spawning, is very necessary, especially of the latter, as it would afford a sure basis for such legislation for the protection of the beds as will soon be necessary.

Aside from the general absence or presence of young on particular beds, it was noticed that a much smaller number were found on or adjacent to the muddy bottoms, or on the sands where there was much grass or sponge. On the beds a large number of young were seldom found where there was much of the red sponge, though there was not always a diminution of the former when the latter was present. The absence of the young may be very readily accounted for if the sponge

* NOTE.—Reference is made to this statement in Report of 1879.

had formed previous to the "spatting," as it would prevent the exposure of the "cultch." The sponge is of very rapid growth, and I was informed that on an unworked bed it had been known to become three or four feet thick in a few months. If, then, it had formed and commenced growing after the "spatting" season, the young would not be as much disturbed by it as they would if the growth had been previous to their advent. This is another reason in favor of the theory that the depth of the water influences the time of spawning, as the effect of the sponge on the numbers of young was greater in deep than in shallow water.

The number of drills (*astyris*) was, generally speaking, in direct proportion to the number of young, and the Pocomoke beds, especially the Bird and Hern Island Beds, appeared to have suffered most from their ravages. A description and sketch of this animal, taken from specimens preserved by me, has been made by Mr. W. H. Dall, Assistant Coast and Geodetic Survey, who has kindly furnished me with copies. Very few star fish and welks and no other enemies were discovered in the Sounds, and the drills are probably the only ones that do any considerable damage.

With regard to the beneficial effect, or the reverse, of fresh water, there can be no doubt that the oysters at least appear fatter and are superior after absorbing it, though they become poorer in flavor. In order to test the effect of fresh water upon them and to determine if the low spring tides had any share in causing the decrease in the numbers on the beds, a dozen oysters were selected from the same bed and haul of the dredge. Six of them were opened immediately and inspected and found to be rather poor, of small size and dark color, but of the ordinary flavor. The remaining six oysters were placed in perfectly fresh water for twenty-four hours, the water being changed several times during that interval. They were then opened and inspected. They were alive and in good order, very fat, or apparently so, and of a creamy white color and much swollen, but of very insipid taste. As the oysters were alive at the end of a day's immersion in fresh water, they cannot well be destroyed by the brackish water of low spring ebbs, to which they would not be exposed for more than six hours, though a continuance of heavy freshets might very seriously affect them. As there is but one river in both Sounds (the Pocomoke) likely to subject the oysters to this evil, for the main beds there is nothing to fear.

The evil effects of sudden jars and concussions are probably due to the breakage of the delicate pedal muscle, which after the spawning season, in common with all other parts of the animal, is in a more or less weakened condition.

In explaining the fact that the oysters in deep water are more affected by cold water and ice than those on the shoals, it is necessary to remember that the lower the temperature of sea water the greater its density, and thus as the surface water becomes cooler it would sink. The freezing point of salt water is below that of fresh. Therefore the oysters in the deep water, or, generally speaking, those remote from the mouths of the streams, may have surrounding them water of a slightly lower temperature, depending upon the amount of salinity, than those oysters near the creeks and rivers that are surrounded by ice. Again, the deep water would be much slower to lose or acquire heat than that on the surface or in less depths, which would necessarily be affected quickly by all changes of weather.

The statement that the oysters recover and reappear after the "sanding" process, must be received with great caution, opposed as it is to most experience. That some few may survive is possibly the case, but that the majority recover after being covered with sand for any length of time is very doubtful.

The testimony of all persons in the neighborhood of the Sounds was to the effect that the beds were deteriorating. In the absence of any reliable observations, extending over any length of time, their opinions must be taken as correct, at least as to the fact, although perhaps only approximately so as to the degree. Accepting, then, the statement, it is necessary to account for the deterioration if possible.

After the original formation and growth of the beds they would at some time, the same conditions continuing, cease their development, neither increasing in size, or in number of oysters, there being a natural limit to expansion in either direction. Supposing, then, a bed to have extended itself as far as the conditions of bottom and water or other natural limit would allow, all future expansion could be only in the number of oysters on the bed; this is limited principally by the amount of food and the room for development (the question of enemies not being considered,

as, there being no increase, if they were not in sufficient numbers to prevent the growth of the bed and number of oysters, they would not be sufficient to cause its destruction or deterioration).

The number of oysters would then, on a limited bed, steadily increase as long as there was sufficient room and food supplied them until they had reached their limit, a rather indefinable one, in that direction, the quality of the oysters not being taken into consideration. Having reached that point, the number of oysters to all intents remain the same as long as the conditions under which they had previously lived were not changed. To cause, then, either an increase or diminution of the number of oysters or size of the bed, a new factor must be brought in, when, all conditions being changed, the life of the animals begins anew and progresses differently. As there can be no doubt that both the beds and oysters of Tangier and Pocomoke Sounds have changed greatly in character since their first discovery, in accounting for that change it is necessary to discover the new factor or factors that have been introduced and that have been instrumental in effecting it. Briefly, the change in the beds has been a material expansion of their limits and a material diminution of the number of oysters upon them, and therefore the causes for such changes must be sought among such as it is known would produce like effects.

Disregarding for the present the agency of man in the matter, the question is, What natural cause or causes would both expand the beds and diminish the number of oysters? A bed is extended naturally by the drifting spat or "young brood" attaching themselves to any clean, hard, and moderately rough substance contiguous to the bed. The locomotive powers of the "spat" exist for but a short time, and, except when assisted by the current, they can only move a short distance, and unless some suitable object soon presents itself for their attachment they will sink into the soft bottoms and die.

The principal expansion of the beds so far as could be effected by nature must, however, have been accomplished long ago, the beds being surrounded originally, and indeed at present, by soft bottoms of a character which would be most destructive to the "brood" unless some substance was interposed between it and them for their reception. Natural expansion can only be achieved to any extent in the manner described, and though probably there is and has been a slow extension of the beds due to natural unassisted causes, their great increase in area during the last thirty years must be assigned to other agents.

The diminution of the number of oysters may be effected by several natural causes. An increased deposit of earthy or vegetable matter upon the beds would, if in sufficient quantities to bury the oyster, effect the destruction of both old and young; but no such deposit has been noticed, nor could it well occur without showing its presence in other ways, principally by changing the channels and causing shoals, and no such changes have occurred, my investigation showing but slight deviations in either channels, shoals, or character of the bottom from that established by the first hydrographic survey of the locality. A change in the character of the water and bottom which would probably follow a change of channel, and might occur without such change, might, by depriving the animals of their proper food, cause their deterioration and destruction; but such a change, though it would certainly diminish the number on the beds, would do so suddenly and the evil effects would be noticed in the oysters remaining, their quality and flavor, indeed their vitality, being very much impaired. No such impairment has been observed, however, the oysters being larger and finer than when the beds were first discovered. That fact alone will eliminate many quantities from the equation, for any natural cause injurious to all the oysters on the beds would be evident at once by an examination of those found at present. If, however, the destruction or non-production of the necessary number of young is accomplished by means that are not harmful to the mature oyster, a cause is discovered for the diminution of all, in harmony with the existing facts.

Considering first the destruction of young; large numbers, immense when compared with the production of other animals, are without doubt naturally destroyed by the falling of the "spat" upon unfavorable grounds, the prevalence of heavy freshets which would drive the "brood" into the bay and probably cause its loss, and the ravages of various enemies. But all these causes have been in operation continually since the first formation of the beds, and the animals have survived and increased while contending with them. Therefore an increase of power for injury must be assigned to one or all of these to account for the diminished number of oysters. Probably the "spat" falls on more favorable ground since the beds were discovered than was formerly the

case, owing to the increased amount of "cultch" due to the fishing of the beds, and aside from that the conditions surrounding and operating upon the beds are so similar to those in the past that the loss of the young could not be much greater from the want of attachment.

The freshets and other natural causes for diminished numbers of young have also been long in operation and the deterioration cannot be justly assigned to them. Remaining then to be accounted for are the ravages of enemies. Those found by us during the season were *astyris* in large numbers, a few welks, and a very few star-fish, but as the oystermen were ignorant of both their presence and destructive effects I am unable to decide whether they have increased or diminished in numbers. There is no doubt that very large numbers of young are destroyed by the drills or welks; fully fifty per cent. on some beds in Pocomoke Sound, and if these small enemies have only within late years entered the Sounds we have one of the principal causes for the deterioration of the beds. But as there is also a marked deterioration upon those beds upon which no drills were found, still another cause must be at work and must be sought in the non-production of the young.

This is caused by the failure of the "brood" oysters, they having been removed or become extinct, thus causing a failure of impregnation. If the theory is correct that there is a mutual fecundation, partaken of by all oysters on the beds, the spermatozoa being formed and milted somewhat prior to the formation of ova, then it can easily be understood that if the oysters are so much separated that even the tides and currents cannot bring the spermatozoa within reach of the adjacent animals, there could be no production of young. Taking for instance the most exaggerated case in both Sounds, that of the Muddy Marsh Bed, it will be seen that the set of the current over it is not generally from any other adjacent bed, the nearest one being Parker's Rock, which is over 3 miles distant; the oysters on the Muddy Marsh Bed were very few, and the mass of shells immense, affording ample surface for the attachment of the drifting "spat," should there be any. But supposing the oysters on the beds to have been so much diminished that they were not sufficient for mutual fecundation, the distance and situation of other beds is such as to prevent the current from bringing the products of generation voided on them to the Muddy Marsh rocks, and there would be, as was noticed, an almost entire failure of young. In the same, though less degree, would the other beds suffer, the amount of spawn voided depending not only upon the number of mature "brood" oysters, but upon their distance from each other and the spaces separating the beds. This theory is supported by the investigations that have been made in England, France, and Prussia, and almost all opinions coincide that the number of young in any spatting season is dependent upon the number of "brood" oysters upon the beds. Indeed, it seems so self-evident a proposition that it is hardly worth while to experimentally establish it. It is necessary, then, having accepted the theory, to determine what proportion of the oysters should be taken off the beds, and what proportion is actually removed. As there is no data to my knowledge derived from observations made in this country to determine the first of these two desired points, it is necessary to turn to the experience of foreign oyster fisheries for guidance, and though the animals and the conditions under which they live are not entirely similar, yet some information may be obtained and a line of investigation marked out for the future.

The following is a synopsis of the deductions of Professor Karl Möbius, professor of zoology in the University of Kiel, whose work, in manuscript, on the oyster was kindly lent me by Professor Baird. The observations were made over the Schleswig-Holstein oyster beds by government officials from 1730 to 1852, and were carried on in, practically, the following manner: Each bed was dredged over in three or six places, according to its size, and the oysters taken were divided into three classes and carefully counted. The classes were denominated "marketable," "medium," and "young growth." The "marketable" oysters were full grown and mature, from 7 to 9 centimeters in length and breadth, and 18 millimeters thick. The "medium" were half-grown oysters, from 16 to 18 millimeters thick and of less than 9 centimeters in breadth. The "young growth" were those one or two years old. From these observations Professor Möbius discovers that there was an average of 421 medium oysters to 1,000 full grown ones. The average of all the observations differs very little from the number given by each, and consequently shows that there was but slight fluctuation in the proportion in one hundred and twenty-two years. The medium oysters are considered by Professor Möbius to be those descendants of the marketable ones that have survived their most

precarious years of existence and escaped their principal enemies, and are consequently likely to reach their full growth. They thus represent the total number of embryos spawned which have survived in the struggle for existence.

From his (Möbius') experiments he decides that an oyster spawns about 1,000,000 embryos in a season, and that 44 per cent. of the mature oysters give forth "spat." [Other authorities are of the opinion that only about 10 per cent. spawn; Professor Möbius' data appear hardly sufficient to justify his conclusion.]

From the above it is evident that in an assemblage of a thousand oysters, 440,000,000 embryos will be voided every season, and of them 421 would survive, or 1,045,000 embryos would be destroyed where one was preserved. But the medium sized oysters also spawn, though they send forth a much smaller number of embryos. Möbius estimates that the 421 in the community would produce about 60,000,000 of "spat." It would therefore require about 500,000,000 embryos to produce 421 medium oysters, or 1,185,000 to produce one. Regarding these results, Professor Möbius is of the opinion that no more than 40 per cent. should be removed each year, but, in my opinion, in order to maintain the oysters at a constant number in the above case, no more than 25 per cent. should be taken, as the one oyster in four would be replaced each year. No comparison between the Schleswig Holstein beds and those on our coast can well be instituted, but as the beds in Tangier and Pocomoke Sounds are of greater extent, and as the more extensive the bed the greater the breeding power, I should consider that, until the annual number of mature oysters produced is known, it would be safe to take about 50 per cent. from the beds, supposing them to be in good condition. That is but an estimate, and may be an erroneous one, but certainly it is not too small. It now remains to be seen what number of oysters are actually removed from the beds. I regret that statistics of the oyster trade in the Sounds are not at hand for reference, and also that the pressure of other work while I was in that locality prevented me from obtaining them. Such observations as we were able to make, however, will furnish a basis for a somewhat rude estimate of the number of oysters and young taken off the beds during the season.

While in Crisfield Harbor, about the 11th October, we counted fifty-seven sail oyster dredgers. The number of bushels carried by them was estimated, and the estimate subsequently verified by the statements of the masters of the several vessels in each class. The following table shows the result for one day:

TABLE I.

Class.	Number.	Number of bushels.	Average number of bushels to each sail.	Class of vessel.	Number.	Number of bushels.	Average number of bushels to each sail.
Schooners	37	2,075	56	Buckeyes	4	45	11
Sloops	12	256	21	Canoes	4	32	8
Total		2,331		Total		77	
		77					
Grand total		2,408					

The day had been a bad one for dredging, and but a small number of dredgers had been at work, and they had come into port much earlier than usual; consequently the average and total number of oysters are below the usual figures. On the same day, in order to ascertain the number of young attached to the mature oysters that were taken off the beds, I had three samples, of a peck each, selected from different vessels entering the harbor and the number of young on the

shells counted. The vessels were of different sizes and from different localities. The results are shown in the table following:

TABLE II.

Vessel.	Number bushels.	Number of young to the peck.			Bushel average.	Localities from which obtained.
		First.	Second.	Third.		
Sloop	13	13	.....	.....	72	
Schooner	30	93	125	163	508	The small proportion from Great Rock, the from Terrapin Sands.
Buckeye	15	33	.....	.....	132	Deep Water Rock, Kedge's Straits.
Sloop	23	73	88	.....	322	Paul's Rock.
Schooner	90	76	78	.....	308	Great Rock.
Schooner	65	32	67	.....	192	
Schooner	80	55	89	57, 40	221	Great Rock and Thoroughfare.
Buckeye	10	1	.....	.....	4	Paul's Rock (Sands).
Buckeye	25	49	.....	.....	196	Great Rock (northern part).
Schooner	50	64	39	23	168	Great Rock.
Schooner	150	67	35	.....	205	California Rock.
Total					2, 228	Average 202 per bushel.

The total number of bushels brought into Crisfield, as seen by Table I, amounted in one day to 2,408, and estimating the number of oysters to a bushel to be between 150 or 200, we have for the results of one day's fishing from 361,200 to 481,600 oysters and about 486,000 young. During the progress of the work in the Sounds, there were twenty-four counts made of the dredgers in sight from the vessel. In order that some idea may be formed of the number of oysters taken by these dredgers, an estimate has been made, based upon Table II, of the number of bushels and young carried off the beds. In forming the estimate, all the vessels in the Sound were divided into three classes—the first being an assemblage of all the different craft, the second only the smaller classes, and the third, where about two-thirds were small, and the remainder large craft. The number of sail counted was then placed in one of these classes, we having observed when among the dredgers the particular class and size of vessel usually working over a particular ground. In order to ascertain the number of bushels to each vessel, the total number of bushels brought in (2,408) was divided by the number of sails (57), which would give 42 bushels as the average to a sail. A closer estimate is obtained from Table II, where the number of bushels assigned to each craft is that given by their master. The total number of bushels (551), divided by the number of sail (12), gives 45 and a fraction as the number of bushels to each sail. I have divided by 12 instead of 11, because the last number in Table II was the result of two days' dredging.

The average number of bushels per sail for the second class, by Table I, is 16.6 bushels; by Table II, 17 bushels. The average for the third class is, by Table I, 29 bushels; by Table II, 33 bushels. In all cases the smaller numbers have been used in calculating the number of bushels of oysters. The total number of bushels taken from the beds in both Sounds in thirteen days was 47,842, and allowing from 150 to 200 oysters to a bushel (though the number is probably larger), there would be removed from the Sounds in the very first of the season from 7,176,300 to 9,568,400 oysters. This, however, is far below the real number, as the entire area and number of sail were not visible at the same time.

In order to estimate the number of oysters removed from the beds in each day, I have divided the Sounds into four sections. The first section comprises all of Tangier Sound north of Little Island and the Mussel Hole Bed. The second section comprises all of that part of the Sound, including the Manokin and Big Annemessex Rivers, between Little Island and Jane's Island. The third section comprises all of Tangier Sound south of Jane's Island. The fourth section all of Pocomoke Sound.

Assembling the number of dredgers known to have been dredging on these different sections and the number of bushels taken by them, I have deduced the following results:

Locality.	First section Upper Tangier.	Second section Middle Tangier.	Third section Lower Tangier.	Fourth section Pocomoke.
Total number bushels taken*	15,135	10,115	18,060	2,673
Numer of days	4	4	6	3
Average per day	3,783	2,523	3,060	891
Average number oysters per day	567,450	378,450	459,000	133,650
Grand total taken off in one day				1,538,550

* 150 oysters are given to the bushel.

Though there were dredgers in large numbers at work early in September and also many during the entire summer, yet in order that any error may be under, rather than over estimation, I will consider the working season to be from the 1st of October to the 1st of May and allow three days in each week for bad weather which would prevent dredging. That allowance will leave 120 working days, and in that time, by the preceding table, over 184,600,000 oysters would be removed from the beds in the Sounds, supposing them to supply the same number during the entire season.

By Table II it will be seen that the average number of young to a bushel was 202. That number represents the number of young oysters attached to the shells of the full-grown ones that were removed from the beds. That the estimate is not above what is actually the case I am certain from the immense numbers of young brought up by our own dredging operations. In making up the estimate 20 and 30 young were frequently found on one shell, and in one case 54 were counted. In estimating the total number removed from the beds in one day, only those vessels dredging on such beds as were known to have a large proportion of young upon them have been considered, and even then the estimate reaches the astonishing figure of 1,238,790. These oysters are those of from two to five months' growth, and may be said to have survived the most precarious portion of their existence, their shells having become hard enough to resist the drills to a certain extent, and they being firmly attached to the mature oyster, and in no danger of destruction from any cause to which it would not be equally exposed. Still, many of them would doubtless perish even if undisturbed, for though all oysters on the beds, mature or others, would suffer if exposed to unfavorable conditions, yet many of those conditions would affect the young and young growth to a greater degree than the mature and more hardy oysters. I will therefore suppose that 50 per cent. of the young taken up would never have reached maturity, and will also make another and very liberal supposition, that by the 1st of April the young would have reached such a size as would make it profitable to open them. That would make the working season, so far as the young were concerned, 104 days, and the number of young removed would amount in that time to 128,834,000, of which about 64,417,000 would probably have attained their full growth. These young are a total sacrifice, never seeing the water again after their removal and generally perishing on distant or adjacent shell heaps.

Many more are probably destroyed by carelessness in disposing of the old shells brought up by the dredge. The dredging is usually across the bed, and the shoal hard ridges noticed along the edges of the beds on the western side of Tangier Sound and on all edges adjacent to muddy bottoms are no doubt caused by the dredgers, who, as they approach the edge of the bed, having dragged across it, haul in their dredges just before getting over the muddy bottoms. They then stand on, tack or "wear," and as soon as on the bed drop the dredges again. In the mean time the crews have been busily "culling" the oysters, and, as likely as not, have thrown over on the soft mud a far larger number of young attached to the shells than they have taken off on the oysters. No account has been taken of the number of mature or young oysters removed by the tongers, and the estimates are based upon observations made at the commencement of the fishing season, when, the prices being low, a smaller number of dredgers would be at work; therefore, there is every reason to believe that the estimate of both classes of oysters is under rather than above the real number removed. We have, then, aside from the ravages of the drills, a yearly destruction of over 64,000,000 young and the removal of 184,600,000 mature oysters to account for the deterioration of the beds.

Whether this extensive fishing is beyond the capacity of the beds or not, cannot be accurately stated; the only information on the subject obtainable being the statements of the oystermen that the beds are deteriorating from that cause. But an estimation of the effect of excessive fishing may be formed by examining its results upon such beds in England and France as have records upon the subject. The most instructive of these are the records of the production of the beds of Cançale Bay, on the northwest coast of France, which extend over a period of sixty-eight years—from 1800 to 1868. The beds in the bay comprise an area of about 150 acres, and from 1800 to 1816 produced from 400,000 to 2,400,000 a year. This, however, was the period of the Napoleonic wars and the fishing was much disturbed by the presence of the English cruisers. During this time the beds became so thickly stocked that the oysters were in some places a yard thick. After the close of the war the fishing improved and the oysters were removed in larger and increasing numbers until 1843. From 1823 to 1848 it is supposed that the dredgers were living upon the oysters accumulated during the period of enforced rest, from 1800 to 1816. In 1817 the number of oysters produced was 5,600,000, and until 1843 there was a constant increase, the number taken in the latter year being 70,000,000. In 1848 it was 60,000,000; thenceforward there was a constant decrease. From 1850 to 1856 the decrease was from 50,000,000 to 18,000,000, supposed to be the effect of overdredging. From 1859 to 1868 the decrease was from 16,000,000 to 1,079,000; the oysters having almost entirely disappeared from the beds, though on account of the suffering condition of the inhabitants of the shores it was almost impossible to prevent it. In 1870 there was a complete wreck of the bottom which could only be remedied by a total prohibition of the fisheries for several years.

From the beds of the districts of Rochefort, Marennes, and island of Oléron, on the west coast of France, there were taken in 1853–'54 10,000,000 oysters, and in 1854–'55 15,000,000. On account of exhaustive fishing, in 1863–'64 only 400,000 could be obtained.

According to the testimony of Mr. Webber, mayor of Falmouth, England, about 700 men, working 300 boats, were employed in a profitable oyster fishery in the neighborhood of Falmouth until 1866, when the old laws enforcing a "close time" were repealed, under an impression that, owing to the great productive powers of the oyster, it would be impossible to remove a sufficient number to prevent the re-stocking of the beds. Since 1866 the beds have become so impoverished from excessive and continual fishing that in 1876 only 40 men and 40 boats could find employment, and small as the number is, they could not take more than 60 or 100 oysters a day, while formerly, in the same time, a boat could take from 10,000 to 12,000.

According to the statement of Mr. Messum, an oyster dealer and secretary of an oyster company at Emsworth, England, made before the Commission for the Investigation of Oyster Fisheries, in May, 1876, there were in the harbor of Emsworth, between the years of 1840 and 1850, so many oysters that one man in five hours could take from 24,000 to 32,000. In consequence of overfishing, in 1858 scarcely ten vessels could find loads, and in 1868 a dredger in five hours could not find more than *twenty oysters*.

The oyster fisheries of Jersey, in the English Channel, afforded employment to 400 vessels. In six or seven years the dredging became so extensive and the beds so exhausted that only three or four vessels could find employment, and the crews of even that small number had to do additional work on shore in order to support themselves.

The foregoing are a few of, though by no means all, the instances that may be quoted in order to show the disastrous effects of overworking the beds, and in concluding the remarks under that head it will be instructive to extract from Professor Möbius' work his prophecy with regard to our own beds, which is here introduced:

"In North America the oysters are so fine and so cheap that they are eaten daily by all classes. Hence they are now, and have been for a long time, a real means of subsistence for the people. This enviable fact is no argument against the injuriousness of a continuous and severe fishing of the beds. * * * But as the number of consumers increases in America the price will also surely advance and then there will arise a desire to fish the banks more severely than hitherto, and if they do not accept in time the unfortunate experience of the oyster culturists of Europe, they will surely find their oyster beds impoverished for having defied the *bioconotic* laws."

The question now to be decided is how the protection of the beds and their improvement is to

be brought about. The protection laws of the State of Maryland, which govern the larger part of the Sounds, are, briefly, as follows: Dredging is allowed from October 1 to May 1. Taking of oysters in other ways from September 1 to May 1. Dredging is not allowed in the rivers and creeks of the Sounds or in their mouths. No steam dredges are allowed. All dredgers and "tongers" must be licensed. Violations of the law are punished by not more than two years imprisonment nor $200 fine. For the enforcement of these regulations there is established a State Fishery Force, consisting of one steamer and several small sloops; one of the latter having jurisdiction over Tangier and Pocomoke Sounds. The officers of this Fishery Force and the sheriffs and constables of the different counties are empowered to make arrests and enforce the law.

The above is the amount of protection afforded by the law if carried out. In the Sounds, in reality, there is none. Neither the State Fishery Force, sheriffs, constables, or any other persons make arrests or enforce the law, the public opinion of the community being against such a proceeding, though every one recognized the necessity when considered in the abstract. I have seen numbers of dredgers at work and the police boat cruising among them, and this was during the latter part of August, when, if at any time, the oysters should have been free from disturbance.

Before deciding upon the measure of protection to be given to the beds, it may be well again to see what has been accorded by foreign governments and with what success. On the Schleswig-Holstein banks the "close time" is from the 9th of May to the 1st of October; no oysters less than 2½ inches in length are removed at any time. The law is enforced, and still the beds are deteriorating.

In Ireland, the "close time" is from May 1 to September 1, and in some localities of the coast from the 1st of April and the 1st of March until the 1st of October and the 1st of November. It is unlawful to dredge or have in possession any oysters or oyster brood during the "close time." The inspector of fisheries can call a meeting of interested persons to decide upon a change of "close time." Inspectors are empowered to permit the planting of oysters and to prohibit the presence of dredges on board any boat during the "close time." The coast guard and constabulary are empowered to enforce the laws, and violators are suitably punished.

The deep-sea fisheries for oysters in the English Channel are governed by rules adopted by England and France. The "close time" is from the 16th of June to the 31st of August. Any boat having a dredge, or other implement used for taking oysters, during that time, is considered as having violated the law. Competent courts of each country have power to punish offenders and the cruisers of each nation power to enforce the law, which is strictly observed by the French fishermen and frequently violated by the English.

In France the oyster beds are protected by stringent and effective laws, which may be briefly stated as follows: The government assumes control over all oyster banks and fore-shores. As occasion may seem to require, an entire bank, or part of it, may be reserved from dredging for a certain time, decided by the local commission. The general practice seems to be to buoy off a third or fourth of a bank each year, which portion is only sufficiently dredged to remove weeds, mud, vermin, &c.; the remainder of the bed is opened to all licensed persons for a certain specified time; the following year another part of the bank is reserved, and occasionally parts are reserved for a longer period. The local commission decides all matters pertaining to the beds and their vicinity, and is composed of the following officers: The inspector of the fisheries, the commander of the fishery guard, two "*Gardes-Maritimes*," one fisherman, master of a boat. The following are the most important regulations made for the guidance of the commissions by the minister of the marine: The beds should not be opened for fishing until the spat has acquired strength to resist the action of the dredge; until the end of January, for example. When a bed has well established breeding capacities, a fourth or fifth part of its total area should be set apart as a reserve, and dredging over such part entirely prohibited. A fishery-guard boat should, whenever practicable, take part in the working of each bed. When a bed is foul or encumbered with weeds or other matter noxious to the development or adherence of spat, it should be open for dredging until cleaned. Beds on which there is never any production of spat shall be opened all through the season. After the working of any bed is over, it should be carefully inspected and, if necessary, the cultch replenished. The "close time" is between the 1st of May and the 31st of August, and is strictly observed. The foregoing regulations have caused a great improvement in the beds on

the French coast, and the regulations of other nations have been made and enforced in time to prevent the depletion of their beds.

As an instance of the effect of this protective policy, when understandingly conceived and rigidly enforced, the beds in the Bay of Arcachon are a good example. In 1870, through overfishing, they had become entirely exhausted; but, by the strict protection afforded them, their fecundity has once more become so great (in 1876) that the waters of the bay from June until August are filled with the young swarm. On a bed when dry, at low spring ebbs, comprising 26.7 acres, there were taken by forty or fifty persons, in about two and a half hours, 60,000 oysters. That part of the bed was immediately buoyed, and no more fishing allowed during the season.

Having seen what is considered necessary for the protection of the beds by European nations, and why it is necessary, the question is, how we can best use their experience. The best remedy for any evil is the removal of the cause, and we have concluded that the cause of the evil in Tangier and Pocomoke Sounds is over-dredging and the destruction of the young brood. Therefore, until the rate of production and the proportion between the number spawned and the number reaching maturity is decided, only a specified number should be taken off of each bed in the Sounds. If observations, both as to the number removed and the increase or decrease of the number to the square yard were continued, a basis might be found for the establishment of the maximum number to be removed; but until that number is established no working of the beds should be permitted between the middle of April and the 1st of November, and none of the beds in Pocomoke Sound should be dredged over at all, except so much as it is necessary to clean them.

There should be a sufficient number of oyster guard-boats to superintend the dredging, both in general and when for cleansing purposes, to collect statistics as to the number of young and mature oysters removed, and to make all observations as to the number to the square yard. They might also collect a good deal of other useful information while on the beds. During September and October they should examine the beds, in order to ascertain the number of young, and those beds having a large proportion should be reserved from dredging operations until the young are able to resist the action of the dredge. No oysters below a certain size should be taken off the beds, and it should be punishable to have those under the specified size in possession. Whenever it is judged that any bed open to general fishing is being worked beyond its capacity, the oyster guard should have power to prevent any further dredging on it. When any bed with a large number of young upon it is open, either the packers or fishermen should be compelled, as far as possible, to return the shells to the beds, or the hard bottoms surrounding them, within a certain specified time, provided that the oysters were opened in their immediate vicinity. Large numbers of young would thus be saved, and the areas of the beds increased. No one should be allowed to take or to possess an oyster having more than a specified number of young attached to it. During the time when not otherwise employed, the oyster guard-boats could be usefully engaged in removing the weeds and grass from the sand shoals and the moss from the closed beds. It must be remembered that dredging is not an unmixed evil, and that the improvement of the oysters and the extended areas of the beds are mainly due to it; but it should be conducted under suitable restrictions, and in this connection may be advised the use of the scrape where it is now prohibited, and the prohibition of the heavy dredges in shoal water and on the soft bottoms.

If there is any animal known to naturalists that is an enemy of the drill and not harmful to the oyster, its introduction into the Sounds would be a great benefit; and, finally, if in the spring either the State or the fishermen would collect the shells from the piles about the packing-houses and deposit them on the hard bottoms contiguous to the beds, they would furnish an excellent "cultch" for the "spat," and probably make a good catch and a permanent extension of the oyster ground.

I have made the above suggestions with the hope that they may in some way bear fruit for the benefit of those engaged in the oyster fishery in the Sounds and Bay. Some more adequate protection than that now offered must soon be afforded, or loss and distress among the large number of people in Maryland and Virginia engaged in the fishery will soon follow from the failure (and that more or less sudden) of the oyster industry. In concluding this part of my report, I cannot do better than to again quote Professor Möbius, whose remarks on the preservation of natural banks of oysters are well worthy of attention:

"In conclusion, I hereby give as the foundation for all oyster culture the most important rules for the improvement of the natural oyster banks.

"First. An oyster bank will yield permanently the greatest profit if it possesses such a stock of full-grown oysters as will be sufficient to maintain the fecundity of the bank in accordance with its bioconotic conditions.

"Second. When the natural conditions will admit of it, the yielding capacity of an oyster bed may be increased by improving and enlarging the ground for the reception of the young brood. The natural banks should be improved by removing the weeds and plants with dredges and properly constructed harrows, and by scattering the shells of oysters and other mussels over the bottom. When circumstances will permit, all the animals which are taken in the dredge, and which kill the oysters or use up their food, should be destroyed. It would be much more judicious and much better for those who eat oysters if the 'close time' could be extended until the 15th of September or the 1st of October, so as to allow the oysters some time after the expulsion of the contents of the generative organs to become fat before being brought to the table. If it is desired that the oyster banks should remain of general advantage to the public and a permanent source of profit to the inhabitants of the coast, the number of oysters taken from the beds yearly must not depend upon the demands of the consumers or be governed by high price, but must be regulated solely and entirely by the amount of increase upon the beds. The preservation of the oyster beds is as much a question of statesmanship as the preservation of forests."

INVESTIGATION CONDUCTED DURING THE SUMMER AND AUTUMN OF 1879.

My assistants during this season were Master H. H. Barroll, U. S. N.; Ensign W. H. Allen, U. S. N.; Mr. W. E. W. Hall.

Mr. Barroll had charge of the compilation and arrangement of the statistics collected, and, in the field, general charge of the work during the absence of the chief of the party.

Mr. Allen calculated the number of oysters to the square yard, and the ratios between the classes; he also tested the water specimens and developed the curves illustrating the changes and range of density.

Mr. Hall was charged with the care and arrangement of the records so as to facilitate their study by myself and others.

INSTRUCTIONS.

The instructions of the Superintendent, issued June 30, 1879, desired that the vessel and party should proceed, as soon as possible, to the lower Chesapeake Bay, and continue the investigation begun and prosecuted during the previous season. The instructions were concise, and, being supplemented by verbal ones, were expressed in general terms. It was intended that the scope of the investigation should include as much of that called for in the instructions for the previous season and such additional matter as the judgment and experience of the chief of the party should dictate. The vessel sailed from Baltimore, Md., for Tangier Sound on July 3, 1879, and the field work was completed on the 30th of October, when she arrived at Philadelphia, Pa.

PLAN OF WORK.

In devising the original plan for the work of the season it was expected that, not only would the party be much larger than it actually was, but that it would be in the field much earlier in the season. This original plan was, briefly, as follows: One division of the party, in a small steamer, was to continue the delineation of the beds and the search for such new ones as might exist. The extension of the survey was to be from Tangier Sound along the eastern shores of the bay.

The other division of the party was, in the Palinurus, to continue the study of the beds already surveyed, the conditions affecting the oysters, and determine, if possible, the effect of changes of temperature and density upon the production and subsequent life of the spat and mature oyster. They were also to ascertain what was the increase in size of the oyster in a given time, and determine the number of oysters surviving in each successive period of life, or establish the natural ratios between the different classes. It was also intended that this branch of the party should

obtain, if possible, satisfactory information in regard to the sex of the oyster, the method of propagation, the number of embryos spawned, and the habits of the animal during the early stages of life; or, in general terms, it was intended to make the study of the embryology of the oyster part of the work of the party.

It was proposed to continue this branch of the inquiry throughout the year, and to make, by means of self-registering thermometers and careful series of density observations and chemical analyses, an exhaustive study of the character and changes of character of the water surrounding the animals on the beds.

Another division of the party was to undertake the collection of statistics, and was to visit and inspect all the dredging vessels and packing houses, that some value might be assigned the dredging factor, to which most of the evils affecting the beds appeared to be due.

The smallness of the annual appropriation made it impossible to carry out the original plan, which was accordingly modified; and the want of funds, which reduced the size of the party and scope of the work, also prevented our getting into the field before July 1. Thus the opportunity for studying the embryology of the oyster and many other matters of interest relating to the reproductive processes was unavoidably lost. It was decided, however, to attempt the execution of the original design so far as was possible with the diminished force and time at our disposal, but upon our arrival at Crisfield, Md., it was found necessary to again modify and change our plan, or else duplicate an investigation that had already been undertaken and ably executed.

Members of the Johns Hopkins Zoological Laboratory had been established at Crisfield for some months prior to my arrival, and Dr. W. K. Brooks had begun the study of the embryology of the oyster, had made experiments in impregnating the ova with the spermatozoa, and had succeeded to some extent in raising the oyster from the egg. The study of the embryolgy of the oyster was thus not only undertaken but concluded, so far as was possible, during that season. The results were alike surprising, interesting, and valuable, and, having been accomplished by so able a worker, did not need any confirmation at our hands, and as it was his intention to continue his experiments in the future and trace the development of the oyster up to the point of attachment, I wrote to the Superintendent proposing a new scheme for the season, which met with his approval, and which contemplated the abandonment of all investigation of the embryological life of the oyster.

The work of the party during this season was, properly, the collection of such information as would conduce to correct answers to the following questions:

1st. Were the oyster beds improving or deteriorating?

2d. What were the causes for such improvement or deterioration?

3d. How is the deterioration, if existing, to be prevented and the beds improved?

In the endeavor to answer these questions it was necessary to investigate many problems and to collect much information having apparently but little bearing upon the main question, but it was my endeavor to limit the extent of the inquiry as much as possible and to direct all the energies of the party to the decision of the three points mentioned.

Though the biology of the oyster should be studied, yet only so much of it was essential to the work he had undertaken as would assist in the solution of the problem presented, and consequently it was desirable to leave an extended investigation in that line to others and to settle ourselves only such points as would, as far as we could see, directly assist us in arriving at correct conclusions.

The investigation conducted during the summer and autumn of 1878 had shown that the beds were deteriorating rapidly, and so far as could be seen the principal cause for this deterioration was the over-fishing of the beds. The remaining question to be answered was, then, how the deterioration was to be prevented.

The main cause was decided to be excessive fishery, which, by removing too large a number of mature brood oysters, diminished in a constantly increasing ratio the fecundity of the bed. Other causes operated also to some extent, but their effects were inconsiderable.

There is but one method of maintaining the fecundity of the beds, and that is by protection, but this protection can be afforded in several ways: Either by restricting the fishery, by enlarging the field for the dredgers, or by insuring the maturity of a larger number of oysters, by artificially

impregnating the ova of the female and protecting the resultant embryos during those periods when they are unable to protect themselves.

To afford protection and maintain the fecundity of the bed in the last-mentioned manner has been attemped by Dr. W. K. Brooks, and his efforts have been in a measure successful. The ova has been impregnated, and the life of the resultant embryos has been maintained for varying periods, the maximum being six days. Whether this success will be of practical benefit remains a matter of conjecture, but should it prove practicable to thus assist nature in maintaining the beds at their greatest productiveness, it will require extended experiments before we can feel assured that the protection afforded in this manner will be sufficient. To confirm the opinion as to the deterioration of the beds, and to show the best method of protecting them in the two remaining ways, has been the endeavor of the party under my command, and to that result have our efforts been directed.

In the absence of positive and correct information as to the life and habits of the oyster, all legislation relating to their protection must be to a great extent inoperative and non-productive of the desired results, and until such information has been obtained the best and easiest remedy for the deterioration would be an extension of the known fishing ground; in other words, the discovery of new and well-stocked beds; as, the number of dredgers being, at least for a few years, constant, they will naturally seek the most profitable field for labor, and leave the overworked beds for the newly-discovered ones, thus giving the former a chance for recuperation. That this is the case is evident by the record of statistics, most of the dredging vessels working on the new beds outside the Sound and on those in the Potomac River on account of the poor returns given by the beds in Tangier and Pocomoke Sounds.

The protection afforded in this manner would, however, be but temporary, the demand for oysters constantly increasing, and the number of vessels working liable to increase with it; consequently it may soon be necessary to legislate for the direct protection of the beds and to limit the supply by law before it is stopped entirely by nature. It is well, therefore, for the best interests of all classes, that such an amount of information should be collected, as to the character of the beds and oysters and the general conditions under which they advantageously live, as would direct protective laws into a channel productive of most good.

The first necessary information to be obtained, and that of greatest moment, would be a knowledge of the positions and areas of the beds. No law could be passed which would protect a bed whose position and boundary was not at least approximately known, nor could any study of separate beds or comparisons of many be undertaken without such knowledge. Again, since nature has already selected these areas as those most favorable to the growth and life of the oyster, they evidently are the best grounds upon which to deposit the young brood, should the experiments of Dr. Brooks prove successful and of practical importance. Indeed, it is hardly possible to enumerate all the advantages of knowing the positions and areas of the natural beds, and it may safely be said that a thorough study of the oyster question would be impossible without it.

Of next importance is the knowledge when the bed is in the condition of greatest fecundity.

In the attempt to attain this knowledge the number of oysters to the square yard of the surface was ascertained during the season of 1878, as described by me in my previous report. The results were of comparative value, and subsequent operations in each year were to show whether the oysters on the bed were increasing or diminishing; or, in other words, the fecundity of the bed, as compared with previous seasons, was to be ascertained.

During the last season these numbers have been again calculated in a similar manner; but, working with a greater knowledge of the subject generally, and a more correct estimate of the desired results, I have devised another method for ascertaining whether the bed is in its most productive condition.

It is evident that in any large community there must be a certain ratio between the individuals of different ages, and that any change in this ratio will indicate an increased or decreased fecundity. It was not, and probably will not be for some time, possible to separate the oysters into classes by ages, except in a very rude manner. The only indication of the age is the size of

the animal, and the oysters were, therefore, separated into four classes, according to size, in the following manner:

The first class contained all those over three inches in length, and embraced all full-grown, mature oysters.

The second class contained oysters between 2 and 3 inches in length, and these were supposed to be mature and fit for market, and between two and three years of age.

The third class contained oysters between three-quarters of an inch and 2 inches long, and represented the young growth of the preceding seasons, being thus oysters from six months to two years of age.

The fourth class contained all oysters under three-quarters of an inch in length, embracing the most minute that could be recognized, and represented the young growth of the last spawning season, or those of less than a year's growth.

By obtaining a sufficient number of each class from each bed it was intended to establish ratios between each class, which, compared with ratios on new and comparatively unworked beds, would show whether the particular locality under examination was in a state of greatest productiveness or not, and by comparing the ratios of successive seasons, the increase or decrease, constant or otherwise, could be ascertained, and the yield of the bed in ensuing seasons predicted.

In order to have another and more correct standard for comparison and to arrive at certain conclusions as to whether the spatting in any season was general and extending to all beds, or confined to particular localities, and in order to know accurately the number of oysters surviving each period of their perceptive existence, numbers of spat collectors were deposited upon the different beds. It was the intention to frequently inspect these tiles, and by counting the number of oysters on each tile at each examination the number of oysters surviving would be ascertained and the age of the previously-established classes would be decided. Thus the life of a community of oysters, free from the dredging influence and protected from all but natural enemies, would be before us from the time of the first attachment until they reached maturity.

The study of their embryo life properly belongs to the zoological student, and the method of propagation and the successive stages of that life must be left to him to determine. It is valuable to the inquiry under consideration, but not essential; as it is evident that we may neglect the early stages of life and yet arrive at correct conclusions as to the number of mature oysters necessary to support the beds in their best condition.

Next in importance to the knowledge of the absolute fecundity of the bed is a knowledge of those conditions which would influence it, and in order that no cause for the deterioration should be neglected, and that all information bearing in any way upon the propagation and growth of the oyster might be collected, several matters of secondary importance have been subjected to investigation and the results embodied in either this or my previous report.

Included under this head are—

Investigations into the temperatures and the influence of increased or diminished temperature upon the mature oyster and embryo.

Investigations into the character of the water, especially as regards its increased or diminished density.

Investigations into the character of the bottom and its influence upon the oyster.

A determination of the direction and velocity of the currents and such collection of statistics of the oyster trade and fishery as would show its present condition and give a value to the dredging factor; and, lastly:

A collection and study of the *fauna* of the beds, particularly of those animals supposed to affect the oyster.

An attempt has also been made to collect the experience of the oystermen and dealers as to the habits of the oysters, and as to the effect of the various changes of environment.

Having shown what, in my opinion, were the objects to be obtained and the direction which the investigation should pursue, it remains now to describe in detail the work of the party in each branch of the inquiry and to decide upon the value of the results.

CLUSTER OF OYSTERS AND SPONGE.
From unworked beds, Chesapeake Bay.
Scale 2/3 Natural Size.

A Hoen & Co Lithocaustic, Baltimore.

DELINEATION OF THE BEDS.

The beds in Tangier and Pocomoke Sounds were surveyed during the season of 1878 and described in my report of the operations of the party during that year. During the last season the survey of the beds has been but an incidental part of the work, only such having been delineated as time and circumstances would permit, though those lying inside the Sounds have been subjected to an examination and survey similar to that of the previous season.

BEDS IN THE NANTICOKE RIVER.

These are small and inconsiderable, embracing a total area of 827,000 square yards.

Most of them lie on the eastern side of the channel and extend a short distance above Ragged Point, though detached groups may be found much further up the river. The oysters and shells are uniformly spread over each surface. Each bed is very hard, and in most cases the probe would not penetrate beyond six inches, but when it was possible to push through the surface stratum a substratum was found of sand. The main part of the river bottom is of mud, and bottom of that description surrounds the beds. Along both shores the mud is firmer and of greater consistency than in the channel, and above Roaring Point on those bottoms are placed large numbers of oysters transplanted from the Middle Ground Bed and from other localities.

The river seems to be a favorite planting ground, and numbers of boats and canoes were working the Middle Ground Bed during the summer in order to obtain the "plants."

The oysters are small, single and in small clusters, and not of very good quality.

The water being shoal, from 5 to 10 feet, no dredging could be done on these beds, and consequently the number to the square yard has not been calculated.

BEDS IN THE LITTLE ANNEMESSEX.

There are only a few small beds in this river, and they are very seldom worked. Their total area is 464,000 square yards. The oysters are in detached groups, separated by spaces of mud and sand, and are small, single and in small clusters. The depth of water varies from 6 to 12 feet.

BEDS IN KEDGE'S STRAIT.

The bottom of Kedge's Strait, from the sands on one shore to those on the other, is covered with scattered oysters to greater or less extent, but they are found in greater numbers in the channel on the soft bottoms than elsewhere. The total area of the beds is 2,894,000 square yards, and three of the beds are of considerable size.

The first lies on the northward side of the Strait, north of Solomon's Lump Light-House, south and southwest of the Western Islands. It extends in a WNW. and ESE. direction (that of the channel), and is $1\frac{1}{4}$ miles long and from one-eighth to one-half mile broad, and is irregular in outline. Its area is 1,244,000 square yards.

Due west of this bed, south of Oyster Creek and NNW. of Fog Point, is the second bed. It extends north and south five-eighths of a mile, and east and west one-third of a mile. Its area is 646,000 square yards.

Southwest and west from this bed, and northwest from Fog Point, in the middle of the Strait and west of the shoals, is the third bed. Its area is 550,000 square yards, and its greatest length NNW. and SSE. is three-fourths of a mile, with an average breadth of one-fourth of a mile.

The depth of water on the inner bed is from 12 to 16 feet, and on the two outer ones from 14 to 19 feet.

The oysters are spread in groups of different areas, separated by spaces of mud and sand, generally the latter, except close to the channel-way, where there is more mud. The beds are in almost all cases very hard; when the probe would penetrate, soft sand was found. The inner bed is much softer than the other two, and has a larger amount of mud. The oysters were small and dark, single and in small clusters of three or four, with no red sponge or grass. On the outer beds the shells were larger and cleaner than on the inner, and generally the oysters in the Strait are larger and with sharper bills than those inside.

The only information that could be obtained with regard to the ground outside the Sounds was that there were a number of beds of different areas lying in the Bay, on the eastern side of the ship channel, especially about and on the shoals off Smith's Island and Kedge's Strait.

The ground being so little known, and the accurate delineation of the beds being so difficult when attempted with a sailing vessel, I considered it better to employ the limited time at my disposal in running tentative lines, off and on shore, and other lines crossing them, with a view to discover the location of the beds and to mark these localities for a more thorough and exhaustive investigation in the future.

In accordance with this plan I dredged over the bottom of the Bay, from Tangier Island northward, running the lines sufficiently close to detect any beds of importance or the presence of scattered oysters. The distance over which the dredge was dragged was always measured; and, when the depth of water was not too great, the bottom was probed with a view of determining whether it was suitable for the oysters.

By reference to the projections it will be seen that these areas occur quite frequently on the shoal ground making off in a southwesterly direction from Tangier Island; that between Tangier Island and Cheesman's Islands there are, in the deep water, no oysters; and that from abreast Cheesman's Islands as far north as the investigation extended were found large areas upon which oysters were living, and in some cases in great numbers. The depth of water does not appear to influence the formation or growth of these beds, some of them lying on the shoals and others in deeper water. Generally speaking, here as in the Sounds, the original beds were formed on the side of the shoals, and wherever there was a sudden change of bottom.

Wherever the solid beds or "Rocks" were encountered, they were found to be long and narrow ridges, extending generally in a northerly and southerly direction, except when near Kedge's Strait, where they ran more to the eastward and westward; and we could, in standing across the beds, but rarely obtain more than one or two hauls of the dredge before we were off the "Rock." The major axis appears here, as elsewhere, to lie in the direction of the current, and probably all natural extension and growth of any bed are in that direction, the spat being carried backward and forward by the ebb and flow of the tides. The large number of beds near and off Kedge's Strait is probably due to the large number of spat brought out from the Sounds through the Strait.

The bottom is generally of hard sand covered with sponge and grass. Near Kedge's Strait some mud sloughs were found, and in some cases the substratum of the beds was of clay; but in most of them the stratum of oysters and shells was too thick and hard to be penetrated.

The beds outside the Sounds have been comparatively free from dredging, and thus present marked differences from those inside.

They are comparatively longer and narrower, and much more sharply defined. Very few scattered oysters are found near them, and the beds are much more solid, unbroken, and much harder, requiring heavier dredges than those used in the Sounds. The most remarkable difference is, however, in the shape and growth of the oysters.

On the undredged beds they are long and narrow, with the lower shells very deep, and bills very thin and sharp. In no case did we find any single oysters of any class, but all grew in clusters of from three and four to twelve and fifteen. The shells were clean and white, and free from mud and sand. Generally there was found a tuft of red or white sponge attached to the clusters, and the mature first and second class oysters were covered and the interstices between them filled with those of the third and fourth classes; numbers of barnacles were also found, and some *crepidula*, but *tubicola* were present only in small numbers.

The oysters found upon beds that have been much worked differ materially, being single and broader in comparison to their length, round and with blunt bills. They are usually dark in color, and have a considerable amount of mud and sand on the shells. The sponges do not appear to be as abundant, and the amount of dredging on any bed may always be known by the appearance of the oysters brought up. Upon an overdredged and almost exhausted bed the oysters will be large and single, blunt-billed, with dirty shells, and with an almost entire absence of sponges, barnacles, and *crepidula;* but the shells will be covered with *tubicola* and bored in many places by the *boring pholad.*

CLUSTER OF OYSTERS AND SPONGE.
From unworked beds, Chesapeake Bay.
Natural Size.

A.Hoen & Co.Lithocaustic,Baltimore.

Late in the last spring the dredgers began working on the beds immediately off Kedge's Strait and the one off Hog Neck, and during the present season the returns show that the beds in the Sounds have been, to some extent, abandoned for those outside in the bay. As so little dredging was done before my examination, I think the results of the dredging operations of the party may be considered as obtained from unworked beds. These results will be alluded to subsequently.

Probably small beds will be found along the shores of the islands from Kedge's Strait to the entrance of Tangier Sound, but as the water was shoal we could not dredge very close in. As far as can be seen at present there is no reason why the existing beds should not be extended very considerably, and such extension will probably take place now that the dredgers are beginning to work upon them. If suitable "cultch" is exposed, probably very large areas will soon be covered with oysters.

Table showing number of oysters to square yard.

Locality.	Number of observations.	Number.
Section 1, west of Kedge's Strait	40	0.37
Section 2, west of Red House	7	0.44
Section 3, west of White House	11	0.30
Section 4, west of Hog Neck	28	0.40
Mean of observations		0.38

The above table of the number of oysters to the square yard has been compiled from all observations made in the bay where there was any evidence of a bed existing, such evidence being given by the probe, soundings, and character of the matter brought up by the dredge.

The numbers to the square yard have been calculated in a manner similar to that described in my previous report, and are, as was pointed out in that report, only of value as forming a standard for comparison. It must be borne in mind, however, in making such comparison, that the hardness of the unworked beds and the closeness of the growth of the oysters would prevent as many being taken by the dredge as on the softer and more open beds in the Sounds.

By referring to the table, it will be seen that the number calculated for each locality is very nearly the same as that arrived at by combining all the observations, and that this number is about 0.4 to the square yard. Accepting that as the standard, the number to the square yard upon a bed which has been dredged for some time should certainly not fall below 0.4, and considering the different characters of the bottom, the number, as shown by the dredge, upon an old bed, should be much larger, unless the bed has been overworked.

The following table shows the number of oysters of each class examined, and also the number of bushels brought up and the percentage of shells and *débris* to the whole amount. As will be seen by the table, the number of the fourth class of this year's growth is very large, showing that however bad the season may have been inside the Sounds it has not influenced the reproduction in the bay.

TABLE I.—*Dredging results—Chesapeake Bay.*

Number of section.	Locality.	Number of hauls of the dredge.	First class.		Ratios.	Second class.		Ratios.	Third class.		Ratios.	Fourth class.*	Number of bushels dredged.				Number of first-class oysters to the bushel.
			Oysters.	Bushels.		Oysters.	Bushels.		Oysters.	Bushels.			Total amount.	Bushels oysters.	Bushels débris.	Ratio débris.	
1	West of Kedge's Strait	52	1,018	8.8	1.49	1,622	4.7	0.17	1,150	2.6	2.32	2,674	23.7	16.1	7.6	0.32	115
2	West of Red House	12	359	3.0	1.00	360	1.0	0.88	318	0.7	1.41	447	7.2	4.7	2.5	0.34	115
3	West of White House	15	135	1.1	1.07	145	0.4	0.16	23	.....	2.15	50	3.0	1.5	1.5	0.50	115
4	Hog Neck Rock	106	1,997	17.3	1.29	2,579	7.5	1.08	2,779	6.4	1.87	5,200	42.2	31.2	11.0	0.26	115
5	West of Tangier Island	15	37	0.3	1.30	48	0.1	1.06	51	0.1	3.74	191	2.2	0.5	1.7	0.77	115
		200	3,546	30.5	6.15	4,754	13.7	3.87	4,321	9.8	11.49	8,562	78.3	54.0	24.3	0.31	
	Mean of ratios				1.23			0.78			2.29						

*75 per cent of this year's growth.

In the foregoing table the ground dredged over has been divided into parallel sections, and all oysters from the beds in those sections have been assembled together.

Section 1 includes all the beds west of Kedge's Strait.

Section 2 the beds west of that position on the chart marked Red House.

Section 3 the beds west of that position marked White House.

Section 4 the beds west of Hog Neck and Cheesman's Island, and section 5 the beds west of Tangier Island.

In compiling the tables I have entered only those hauls of dredge that have been taken on the beds or where the oysters were in considerable numbers. The scattered and detached groups and single oysters have not been considered. Section 5 is not an important one, owing to the very small areas of all the beds encountered on it.

By examining this table it will be seen that a total of 54 bushels, amounting to 21,183 oysters, were examined; that from 200 hauls of the dredge we obtained 78.3 bushels of oysters and shells, and that 31 per cent. or 24.3 bushels of this matter consisted of shells or other *débris*, and this percentage does not differ materially from that found on each section.

Section 5 is not considered, as the percentage there does not entirely represent shells and other *débris* of the bed, but rather the sponge and grass of the sand shoals.

Regarding these beds as in their natural condition of healthy life, it is inferred from the deduced table that, other things being equal, a larger percentage of *débris* would indicate that the bed was not giving, for the same amount of labor, its natural return; or, in other words, that the mass of old shells brought up by the dredge was out of proportion to the number of oysters. This percentage is of value as indicating the most profitable working grounds, and also as indicating, when very large, that the bed has been overworked and its population destroyed, as the percentage of shells bears the same relation to the oysters as the unoccupied dwellings in a city do to its inhabitants; an increased percentage means a decreased population.

It is evident that there should be a certain ratio between the oysters of different ages, and in general terms the number of young should exceed the mature, thus allowing for the natural depletion in each period of growth. Our present knowledge, however, is not sufficient to allow the assignment of exact values to this ratio, and the ratios between the different classes are too irregular, owing to the variations in the spawnings in the several seasons, to allow their acceptance as a standard. One thing, however, may be assumed as an axiom, and that is, that the number of young growth on a bed should always exceed the mature oysters, for if there are no young oysters in the community there will soon be no old ones, and as there is a constant depletion of each class, the young must sufficiently outnumber the old to allow those ravages and still adequately supply the demand and fill up the vacant places in the higher classes.

An inspection of Table I will show—

1st. That 75 per cent. of the fourth class were of this year's growth.

2d. That the ratio between the third and fourth classes is the largest, and between the second and third classes the smallest.

As the second class represents oysters of between two and three years of age, and as the ratio between the second and first classes is large, I judge that there was a successful spatting on these beds in 1876; and as the third class represents, on the whole, oysters of the season of 1877 and 1878, and as the ratios between those of that class and those of the second is small, I infer that the seasons of 1877–'78 were bad spawning ones. Again, the fourth class is principally of this year's growth, and the ratio of fourth to third class is large, from which I infer—what was the case—that the spatting of the last season on these beds was successful.

As already explained, the third and fourth classes practically represent the offspring of three successive spatting seasons, and thus contain the young growth on the bed, while the first and second classes represent the mature oysters. If, then, we compare the mature with the young, we have at once a sure indication of the state of the bed so far as its fecundity is concerned.

In order that the areas under consideration might be as similar as possible to the extensive

ADULT OYSTER–NATURAL SIZE
From Bird Bed, Pocomoke Sound.

A.Hoen & Co.Lithocaustic.Baltimore.

beds inside the Sounds, I have only used for the following table the largest three sections—Nos. 1, 2, and 4:

TABLE II.—*Dredging results—Chesapeake Bay.*

Number of section.	Locality.	Oysters.		Ratios.
		First and second classes.	Third and fourth classes.	
1	West of Kedge's Strait	2,640	3,824	1.06
2	West of Red House	719	765	1.06
4	Hog Neck Bed	4,576	7,979	1.70
		7,935	12,568	
	Mean of ratios			1.58

Accepting this mean ratio of all young growth to mature oysters, upon comparatively unworked beds, as the standard, it is inferred that the ratio on any bed should not fall below 1.5 or 1.6.

FECUNDITY OF THE BEDS IN THE SOUNDS.

In order to ascertain whether the fecundity of the beds in the Sounds was the same as that of those outside in the bay, a very thorough dredging was continued during the summer and autumn, and the oysters classified according to the plan already described, and the results are assembled in the following table:

TABLE I.—*Dredging results—Tangier Sound.*

Locality.	Number of hauls of dredge.	First class.			Second class.			Third class.			Fourth class.	Bushels dredged.				Number of first-class oysters to a bushel.
		Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Total amount.	Bushels oysters.	Bushels débris.	Ratio débris.	
Middle Ground Nanticoke	1	17		5.18	88		1.06	93		0.43	40					
Shark's Fin	57	382	2.9	1.28	489	2.3	0.92	453	1.6	0.92	418	10.25	6.8	9.4	0.58	246
Were Point	54	340		0.91	311		0.77	241		0.59	142	6.0				
		722			800			694			560	16.25				
Tyler's Bed	14	102	0.5	1.45	148	0.4	0.39	59	0.2	0.49	29	3.50	1.1	2.9	0.72	
Horsey's Bar	2	15		1.06	16		1.37	22		1.14	25	0.50				
		117			164			81			54	4.0				
Drumming Shoal	39	666	3.0	2.16	1,439	4.2	0.91	1,303	3.0	0.47	607	12.5	10.2	2.3	0.18	220
Cow and Calf	6	51	2.8	0.66	34	1.6	0.68	23	1.3	1.06	586	1.0	5.7	9.5	0.62	162
Grass Tangier	65	417		1.25	520		1.06	554				14.25				
		468			554			577				15.25				
Turtle Egg Island	54	375	2.3	2.40	900	2.6	1.57	1,419	3.2	0.54	770	16.0	8.1	7.9	0.50	
Mud Bed	53	521	3.2	3.03	1,580	4.6	1.34	2,121	4.9	0.52	1,115	21.0	12.7	8.3	0.40	
Chain Shoal	47	330	1.6	1.09	359	1.0	3.55	1,374	3.1	0.70	966	21.0	5.7	15.3	0.72	
Piney Island Bar	211	1,282	6.2	3.00	3,850	11.3	2.56	9,857	22.8	0.41	4,070	75.2	40.3	34.9	0.45	204
Muscle Hole	97	1,176	7.2	2.34	2,752	8.0	1.68	3,876	9.0	0.48	1,876	45.0	24.2	20.8	0.46	
Manokin River	93	881	4.6	1.41	1,282	3.7	0.48	2,158	5.0	0.49	1,169	26.2	13.3	12.9	0.49	188
Big Annemessex River	41	392	2.0	3.88	1,521	4.4	1.21	1,846	4.2	1.03	1,905	29.2	10.6	18.6	0.63	196
Harris' Bed	108	559	2.7	3.11	1,740	5.1	2.97	5,174	11.9	0.62	3,204	21.0	19.7	1.3	0.06	
Terrapin Sands	54	426	2.8	2.26	996	2.8	2.18	2,110	4.8	0.61	1,292	26.0	6.4	19.6	0.75	
Jane's Island	17	150	0.8	4.23	784	2.3	3.53	2,771	6.4	0.43	1,209	14.5	9.5	5.0	0.34	
Woman's Marsh	127	852	7.4	1.13	968	2.8	2.30	2,229	5.1	0.42	947	65.0	15.3	49.7	0.76	115
Great Bed	152	1,408	8.0	1.89	2,665	7.8	3.02	8,056	18.6	0.51	4,153	116.5	34.4	82.1	0.70	176
Little Thoroughfare	35	82	2.2	2.32	190	1.8	3.69	702	10.9	0.49	346	6.5	14.9	7.6	0.33	140
Great Thoroughfare	33	230		1.90	438		9.15	4,010		0.36	1,483	16.0				
		312			628			4,712			1.829	22.5				
California Bed	82	663	3.3	0.93	620	1.8	1.75	1,085	2.5	0.71	767	24.0	7.6	16.4	0.68	196

TABLE I.—*Dredging results—Tangier Sound.*—Continued.

Locality.	Number of hauls of dredge.	First class.			Second class.			Third class.			Fourth class.	Bushels dredged.				Number of first-class oysters to a bushel.
		Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Number of bushels.	Ratios.	Number of oysters.	Total amount.	Bushels oysters.	Bushels débris.	Ratio débris.	
Johnson's Bed	18	39	0.2	1.38	54	0.1	1.20	65	0.1	0.92	60	2.0	0.4	1.6	0.80	
Dog Fish Bed	32	213		0.68	145		1.12	163		0.65	107	11.5	.....	.....	.....	152
Trevise Bed	1	14	2.2	2.14	30	0.70	1.10	33	0.4	0.91	30	1.0	.....	.....	.....	.....
Shell Bed	31	88		0.42	37		0.38	14		1.78	25	31.0	3.3	33.7	0.91	.....
Flat Bed	16	44		0.81	36		0.50	18		0.44	8	5.0	.....	.....	.....	.....
		359		0.69	248		0.91	228		0.74	170					
Muddy Marsh Bed	22	59	0.3	0.20	12	0.03	0.75	9	.....	1.67	15	14.2	0.3	13.9	0.97	.....
Bird Bed	60	237	1.2	0.19	46	0.10	0.37	17	.....	3.23	55	50.0	1.3	48.7	0.97	188
Hern Island Bed	39	180	1.0	0.34	61	0.20	3.62	221	0.5	0.16	36	23.0	1.7	21.3	0.92	178
		417		0.26	107		2.22	238		0.39	91					
Parker's Bed	22	154	1.2	0.99	153	0.40	5.85	895	2.0	0.33	296	14.2	3.6	10.6	0.74	120
Brig Bed	23	166	1.3	0.57	89	0.20	1.07	95	0.2	0.52	50	77.0	7.7	6.9	0.77	120

By referring to Table I it will be seen that on all the beds in Tangier Sound, from Fishing Bay down to the Great Rock, with one exception, that of Chain Shoal, the maximum ratio is that of the second class to the first. The inference is that there was a successful spatting season on all the upper beds in 1876 or 1877, probably the former.

Again, the minimum ratio, as far down the Sound as the Mud Bed, is that of the third class to the second, showing that on the beds above the Mud Bed there was not a successful attachment in 1878, which was the case as attested by ourselves. The remaining ratios on these beds show that there has been some attachment during the present season.

Leaving the Chain Shoal Bed for the present, the minimum ratio on all the remaining beds is that of the fourth class to the third, showing that there has been but little attachment of young during the season of 1879.

The remaining ratios show that there was a partial attachment of young on the beds between Turtle Egg Island Bed and the Great Rock during 1878, and a partial attachment on the remaining beds north of Jane's Island during 1876 or 1877, while there was a successful spatting on those lower beds during 1878, which conclusion was found to be correct by our observations during that season.

Arranging these deductions in tabular form, we have the following:

Table showing the success of spatting in different seasons—Tangier Sound.

Year.	Section No. 1. Upper Tangier beds down to Mud Rock.	Section No. 2. Middle Tangier, Turtle Egg Island, to Great Rock.	Section No. 3. Lower Tangier, below Jane's Island.
1876 or 1877	Successful	Successful	Moderately successful.
1878	Unsuccessful	Moderately successful	Successful.
1879	Moderately successful	Unsuccessful	Unsuccessful.

The Chain Shoal differs from the beds of its section, the upper, in having its successful spatting season in 1878, and its moderately successful one in 1876 or 1877, while during the last season there has been but a small attachment; it thus assimilates itself to Section 3.

If Table I is again referred to for the Pocomoke beds, it will be found by assembling the upper

beds under one head and considering the Bird and Hern Island Beds to be, what they practically are, one bed, we have a table for Pocomoke, as follows:

Table showing the success of spatting in different seasons—Pocomoke Sound.

Year.	Upper Pocomoke.	Muddy Marsh.	Bird and Hern Island Beds.	Parker's and Brig Beds.
1876 or '77	Unsuccessful	Unsuccessful	Unsuccessful	Moderately successful.
1878	Successful	Moderately successful.	Successful	Successful.
1879	Moderately successful.	Successful	Moderately successful.	Unsuccessful.

With regard to these tables, it must be remembered that the success or want of it is only by comparison with previous years, nor does it necessarily mean that there has been even a moderate attachment, but only that one year was better than another.

By combining the first and second classes and third and fourth on each bed, and combining such beds as are similarly situated and contiguous, I have arranged the following table for comparison with the similar one of the dredging results on the beds in the bay:

TABLE II.—*Dredging results—Tangier and Pocomoke Sounds.*

Name of bed.	Oysters. First and second classes.	Oysters. Third and fourth classes.	Ratio.
Shark's Fin	871	871	1.0
Were Point	651	383	0.58
	1,522	1,254	0.82
Tyler's Bed	250	88	0.35
Horsey's Bar	31	47	1.51
	281	135	0.48
Drumming Shoal	2,105	1,909	0.90
Cow and Calf	85	23	0.25
Grass Tangier	937	1,140	1.21
Turtle Egg Island	1,275	2,189	1.71
Mud Bed	2,101	3,236	1.53
Muscle Hole	3,928	5,752	1.46
	8,326	12,340	1.48
Chain Shoal	689	2,340	3.41
Piney Island Bar	5,132	13,927	2.71
	5,821	16,267	2.79
Manokin River	2,163	3,327	1.51
Big Annemessex	1,913	3,751	1.96
Harris Bed	2,299	8,378	3.64
Terrapin Sands	1,392	3,402	2.44
Jane's Island	934	3,980	4.26
Great Bed	4,073	12,209	3.00
	5,007	16,189	3.23
Woman's Marsh	1,820	3,176	1.74
Little Thoroughfare	272	1,048	3.85
Great Thoroughfare	668	5,493	8.22
California Bed	1,283	1,852	1.44
Johnson's Bed	93	125	1.34
	2,316	8,518	3.67
Dog Fish Bed	358	270	0.75
Flat Bed	80	26	0.32
Trevise Bed	44	63	1.43
Shell Bed	125	39	0.31
	607	398	0.65
Muddy Marsh	602	24	0.04
Bird Bed	283	72	0.25
Hern Island Bed	241	257	1.07
	524	329	0.62
Parker's Bed	307	1,191	3.87
Brig Bed	257	145	0.56

The ratios underlined thus (.....) are the only ones considered, and show the ratio of young growth to mature oysters in each locality.

I find the ratio of young growth to mature oysters to be, generally speaking, a constantly increasing one from the head of Tangier Sound to the last section.

In my report of the investigation carried on in 1878, I called attention to the noticeable absence of "young" on the beds above Piney Island Bar and Kedge's Strait, and to the large attachment on the southern beds, and the ratios in Table II begin increasing materially on those beds where there was a successful attachment of young during the previous season.

Referring to the "Spatting Table," it will be seen that on the upper section there has not been a successful attachment since 1876–'77; hence, the mature oysters from two to three years old, the

growth of those seasons, should be in the ascendant naturally, and hence the small ratios on the upper section.

Apparently the ratios should be about the same on the middle section, as its successive spatting season was also in 1876–'77; but the moderately successful season was in 1878, while on the upper section it was in 1879; and as brood oysters are constantly taken from the beds in constantly increasing numbers it follows that the yield of each succeeding year will be less. As an additional cause, more of the beds in the upper section are worked during the summer than in the others.

During the season of 1878 there was an extraordinary growth of young on Harris' bed, which accounts for its large ratio, and the increase of the other ratios over those of the first section is due to some extent to the attachment of the season of 1878.

On the lower section the ratios are very large by reason of the successful attachment in 1878, and the but moderate success of the seasons of 1876–'77.

The variations in the ratios can thus be accounted for by the success or failure of different spatting seasons, and no doubt this success or failure has its influence, but that its effects are not invariable can be seen by reference to the ratios of Pocomoke Sound.

With the exception of Parker's Bed, a small bed lying near Watt's Island and which has not been dredged as extensively as the others in Pocomoke Sound, we find the ratio of young growth to mature oysters exceedingly small. In no case do the former predominate. From this, according to the deductions from the Tangier beds, it would be inferred that the seasons of 1876 or 1877 were unusually successful ones for the attachment of the spat, and that subsequently there has been no successful season.

By referring to the spatting table we find, however, that the spatting season of 1876 or 1877 was on the whole unsuccessful, and the seasons subsequent have either been successful or moderately so, and this conclusion is supported by our observations during 1878. But as the success or non-success as shown by the spatting table is comparative only, we can only assume that whether successful or not the attachment was not sufficient as one explanation of the small ratios found in Pocomoke.

Consequently the variation in the success of different spatting seasons is not sufficient to explain unusual and abnormal changes in the ratios of the young growth to the mature oyster.

It is evident that the removal of a large number of mature oysters from a bed would show apparently an increased fecundity, by increasing the ratio of young growth to mature oysters, and this apparent increase would be observable for at least two years, or until the young growth became in turn mature, when, as the reproduction would naturally be diminished by the removal of the brood oysters and consequently there would be a smaller number of young growth, and as the young growth of the previous year would be in that time mature, the ratio would suddenly turn in the opposite way, and be as abnormally small as it had been abnormally large. Once having taken this turn, and the fishing still continuing, the ratios would constantly decrease. A few fluctuations might occur now and then, but the general tendency would be a diminishing one.

Nature arranges her own laws of supply and demand, and the ratios she establishes between the different classes in any community are most likely to be the necessary ones, and such are the only ones that can be accepted as standards. We have established that upon the unworked beds in the Bay the ratio of young growth to mature oysters is about 1.5, but as this is the result of but one season's observations, and those over a somewhat limited area, it would be rash to accept that standard exactly or to draw rigid inferences from comparison with it. Therefore, in order to allow a sufficient margin for the variations of different seasons and localities, it will be better to consider the normal ratio as between 1 and 2, and consequently any increase or decrease of that ratio will be an indication of diminished fecundity, and, all things remaining the same, the eventual destruction of the beds.

Comparing the ratios of the beds in the Sounds with that established as a standard, we find that—

1st. All beds above the Grass Tangier fall below the minimum ratio.

2d. That the groups including Tangier Grass and Muscle Hole are within the limit, as are the beds in the Manokin and Big Annemessex Rivers and the Woman's Marsh Bed.

3d. That all other groups exceed the maximum ratio.

4th. That all beds in Pocomoke, with the exception of Parker's Bed, are below in minimum.

Instituting another comparison, that of the percentage of *débris* to the total amount brought up, we find that, with the exception of Drumming Shoal, Harris' and Jane's Island Beds, the percentage constantly increases to the southward, and that in Pocomoke it is larger than elsewhere, and larger on the Muddy Marsh and Bird Beds than on any others.

A coincidence will here be noticed in the increased ratios in lower Tangier and the increased percentage of *débris*, and in Pocomoke in the small ratios and very large percentage of *débris*.

Table showing number of oysters to the square yard.

TANGIER SOUND.

Name of bed.	Number of hauls of dredge.		1878.	1879.	Differences.
	1878.	1879.			
Horsey's Bar	.....	6	.....	0.254	.....
Tyler's Bed	.....	12	.....	0.529	.....
Were Point	14	50	1.254	0.840	—.414
Shark's Fin	.....	80	1.014	0.328	—.686
Drumming Shoal	.....	57	.....	0.994	.....
Tangier Grass	10	100	1.064	0.372	—.692
Turtle Egg Island	13	55	0.382	0.295	—.087
Mud Bed	.....	52	0.642	0.515	—.127
Chain Shoal	.....	41	1.539	0.242	—.296
Piney Island Bar	49	198	0.687	0.544	—.143
Muscle Hole	36	87	0.826	0.746	—.080
Manokin River	25	90	0.134	0.320	+.186
Big Annemessex River	7	41	0.560	0.665	+.105
Harris' Bed	40	109	0.281	0.423	+.142
Terrapin Sands	12	51	0.271	0.423	+.152
Jane's Island	.....	14	.....	0.670	.....
Woman's Marsh	32	110	0.240	0.125	—.115
Great Bed	36	151	0.165	0.265	+.100
Little Thoroughfare	9	35	0.145	0.104	—.040
Great Thoroughfare	10	32	0.115	0.236	+.121
California	36	79	0.212	0.261	+.049
Johnson's	4	17	0.187	0.074	—.113

POCOMOKE SOUND.

Upper Pocomoke Beds	.....	79	.....	0.139	.....
Muddy Marsh	3	20	0.405	0.070	—.335
Bird Bed	4	58	0.360	0.124	—.236
Hern Island Bed	6	39	0.294	0.110	—.184
Parker's Bed	.....	21	0.573	0.303	—.270
Brig Bed	.....	23	0.269	0.154	—.115

The number of oysters to the square yard ascertained, as described in my report of the investigation of 1878, has been calculated for each bed, and the results tabulated, together with those of the previous season, for convenience of comparison. Though a standard has been established by the number found on the unworked beds in the bay, no comparison, except in one way, is just, the conditions of bottom and difference of growth upon the worked and unworked beds differing so materially. The number on any bed, obtained by the method we have used, will always be much less than what is really the case, but they will be much less true on an unworked bed than upon one which has been for some time subjected to dredging influences, and where the bottom is soft and yielding, and the oysters grow singly or in small clusters instead of being cemented together and to the surface stratum, as they are on the undredged beds. Therefore, any number obtained from a bed which has been worked should be larger than that obtained from an unworked

one. How much so it is impossible to say, but it is evident that a smaller number would indicate a failure of the mature oysters.

In calculating these numbers only first and second class oysters have been considered.

It will be seen by the table that on all the beds above Kedge's Strait there has been a marked decrease in the number of oysters to the square yard. That on the remaining beds, with the exception of Woman's Marsh and Johnson's beds, and considering the Thoroughfare beds as one, there has been an increase in the number of oysters. That on all the beds in Pocomoke Sound there has been a marked decrease.

It will also be seen that on many of the beds the number falls below the standard of 0.4, that on none of them is it very much greater, and that, generally speaking, the numbers are less than the standard on those beds that show a gain upon the number established during 1878.

It would appear, then, by one comparison, that most of the beds have not a sufficient number of mature oysters upon them; and by the other, that however many were taken off, yet nature could more than supply the demand. These inconsistent results may be the result of several causes. The standard may be too high; but, as has been explained, if the beds are in equally good condition, the probability is that the dredge would bring up a larger number from the old than from the new beds. The smallness of the numbers on the lower beds may be due to the greater depth of water and hardness of the bottom, though they do not differ greatly in that respect from the beds in the bay, however much from those in the northern part of the Sound.

It would not be wise to decide hastily, upon the evidence of the numbers to the square yard, that the beds are either deteriorating or the reverse, especially as the comparison has been of but two seasons. If, after they have been continued for some time, there should be an increased number shown, it may be considered differently; but, as all experience testifies to the deterioration of the beds, the inconsistency of the results shown by the table can probably be explained in another way than by assuming the standard number to be too great, and this explanation will be subsequently attempted.

INFORMATION OBTAINED FROM "SPAT COLLECTORS."

In order to ascertain when the first attachment of young took place on each bed, the comparative extent of such attachment, the influence of bottom and depth of water upon the attachment, and, finally, the increase in size of the oyster and the number surviving each period of their existence, I placed early in July twenty-four spat collectors on the beds in the Sounds; but I regret to say that the collectors were removed by some ill-disposed persons almost as soon as placed.

The last hurdle, as the bundle of tiles was called, was in position on July 14, and on July 15 only four remained in position, and after the 1st of August there was but one left (No. 7, in the Big Annemessex River).

The hurdles were composed of eight or sixteen half-round tiles, lashed on a wooden frame, and so arranged that the frame rested on the bottom, the tiles being thus raised about six inches above the bottom. The tiles were ordinary earthenware ones, unglazed, and were always placed so as to have their concave side underneath. As long as the hurdles remained in position they were frequently examined in order to ascertain the advent of the young brood, and from those examinations I am of the opinion that the first attachment of oysters took place about July 17, as on that day we discovered, with the aid of the microscope, oysters on Hurdle No. 12, on Chain Shoal, and on the 19th, in the same way, found them on No. 7, in the Big Annemessex. On July 24 they were observable on the hurdles on the Great Rock, both in shoal and deep water. Though the attachment probably began about the middle of July, yet it was only evident on the tiles, as our dredging operations did not discover any attachment before the 12th of August, when the young brood were found in moderate numbers on all the beds in both the Sounds.

The number found in Pocomoke Sound was much smaller than in Tangier, and the number on the Upper Pocomoke beds and on the Muddy Marsh bed was smaller than on the lower ones. The attachment appears to be proportional to the number of oysters, such beds as the Muddy Marsh, for instance, having very few young; but as the bed is badly broken up, this may be owing to the absence of proper cultch. The young appear to select the cleanest and smoothest shells for attachment, and we always found that the "boxes," or those shells which had not been separated

completely, contained the largest number of young brood. We also found that the size of the young depended, to a great extent, upon the depth of water. Those first detected by us were from two millimeters to one centimeter in length, and as the shoal-water oysters spawn first, and as we found the young of the largest size in shoal water, I infer that the attachment of the oyster occurs very near the location of the parent.

The hurdle in the Big Annemessex was subjected to four examinations. It was placed in position on July 9, and on July 19, when the first examination was made, there were a few oysters on the tiles, but so small that a microscope was necessary in order to recognize them.

The second examination was on August 2, and the oysters were then quite perceptible and easily counted. The total number of oysters on the tiles was then 1,506; deducting those on tile No. 7, which tile was removed, there were 1,177. The number on a tile varied greatly, the maximum being 348 and the minimum 26.

The third examination was on the 23d of August. The oysters had increased very much in size and in numbers. The total number on the tiles was now 1,334, showing an increase of 0.13 per cent. of the number at the second examination. The number on the lower side of the tiles was much larger than on the upper. A tile (No. 2) was removed, and, deducting the number of oysters on it from the sum, there were 1,202 still on the hurdle. A few oysters were injured, probably by raising or lowering the hurdle from and to the bottom.

The fourth examination was on the 10th of October. The total number of oysters was then 539, showing a decrease of 55 per cent. At this examination about two-thirds of the oysters were of the third class, or over three-quarters of an inch in length, and two of them were over two inches long, being thus of the second class. All, however, could be distinguished as of very recent growth, being very long and thin, with thin, delicate shells, easily broken with the thumb-nail or point of a penknife. The largest numbers were still found on the lower sides of the tiles. A moderate number of oysters had been injured by rough handling.

I infer from the four inspections made of this hurdle, and from the one or two made of others before they were removed, that the first attachment of young began, as I have said, about the middle of July, and continued until about the 20th of August, as on the 23d of that month there was no indication of any recent attachment. Probably it reaches its maximum number about the end of July, and decreases afterwards. The mortality after the 23d of August was very great, fully 50 per cent. perishing from some unknown cause, which, though unknown, is certainly natural. We did not notice any evidence of the destructive effects of drills or other animals, though their agency would only be discovered by the evidence of the holes in the upper valves, but as those valves were never present, it cannot be said with certainty that the destruction was not due to them. Whatever the cause, the fact is that 50 per cent. perished in the first six weeks of their existence.

The tiles have shown that the increase in size is much greater than was supposed, and are the first and only authentic evidence upon that point which has been produced with regard to the American oyster. Again, it is conclusively shown by these tiles and some others that were dredged up from the Woman's Marsh beds (Hurdle No. 24), that the greatest attachment is on the lower concave side, and consequently that whatever may be the movements of the embryo oyster before attachment, during the period just prior to it they are near, if not on the bottom, and in seeking their place of attachment they must rise. In this they are similar to the European variety. The selection of the lower sides of the tiles and the interior of the "boxes" may be an effort of nature to provide some protection for the young brood, by, to a certain extent, inducing them to seek dark and secluded points for attachment, or the large number found in such places may be due to the inability of the various enemies of the spat to get at them when thus protected.

It is a matter of very great regret that we have not a large number of specimens and observations for comparison, as all the future investigations in this field would be greatly assisted by an accurate knowledge of the rate of decrease in number and increase in size of the oysters, and it is to be hoped that the hurdle in the Big Annemessex will be allowed to remain in position long enough to permit the meager, yet valuable, information it can produce to be made public.

INVESTIGATION OF TEMPERATURES.

It was intended that a self-registering thermometer should be placed on each hurdle, and that the temperature to which the young were exposed should be noted at each examination. Fortunately, considering the fate of the hurdles, the thermometers were not received in time to be used as was intended, and after the disappearance of the spat collectors it was not considered advisable to expose the thermometers to the same risks. About the last of July, however, I had the temperature of the surface water recorded every two hours, and considering that there is probably but little variation in the limits of the Sounds, I have plotted the accompanying curve of maximum and minimum temperatures from July 29 to October 1. It will be seen that these curves are very irregular, and that the greatest irregularities occur during the month of August, and that the greatest difference is between the 6th and 10th of August, one of 15° in four days. On the 15th there is a change of 8°, and on the 28th of 12°.

About the 4th of August I determined to utilize the channel buoys as marks for the positions of thermometers, hoping that they might thus escape the observation of those who were inclined to remove them. Accordingly, we placed four self-registering thermometers on the beds; one at the foot of the buoy on the Shark's Fin, one on the buoy on Piney Island Bar, one on the buoy off Watts' Island light-house, and one on the buoy off Syke's Island, about the middle of Pocomoke Sound. We were enabled to make several examinations of these thermometers; but about the 1st of September, finding that one had been stolen, I concluded to remove the others before they shared the same fate.

The curves of maximum and minimum temperature given by these thermometers, and also the range of variation, are shown on the same sheet with the curves of surface temperature.

The thermometers were in place too late, and for too short a period, to allow any safe conclusions to be based upon the information given by them; but it is noticeable, as an interesting coincidence, that the curves of both surface and bottom temperatures show the greatest variations about the time when the young were what is known as "spat," or during the period of and just before attachment; the young on the shoal beds presumably attaching by early August, and those on the deep water or southern beds somewhat later. I regret that it was impossible for me to more thoroughly study the effects of the change of temperature, as I think the failure or success of the spatting, other things being equal, will be found to depend mainly upon the temperature to which the mature oyster and embryos are exposed during the spawning season.

INVESTIGATION OF THE CHANGES IN DENSITY OF THE WATER.

In order to have definite information as to the change of density of the water surrounding the oysters, and regarding such changes during the spatting season as of most importance, and as the maximum change would be most likely to occur about the time of the spring tides, I determined to obtain specimens of water on a certain number of sections across each Sound at high and low water of the spring tides. The sections were located as follows, and are shown on the sketches accompanying this report:

Section No. 1 was just above Hooper's Strait and at the mouths of the Nanticoke and Wicomico Rivers, in order that the influence of both the strait and rivers might be shown.

Section No. 2, for the same reason, was north of Kedge's Strait and across the mouths of the Manokin and Big Annemessex Rivers.

Section No. 3 was across the entrance of both Sounds, south of Watts' Island.

Section No. 4 was across the middle of Pocomoke Sound, that the influence of Guilford and Mesongo Creeks might be known.

Section No. 5 was above the natural beds of Pocomoke Sound and across the mouth of Pocomoke River.

Stations were selected on these sections in such a manner as to obtain specimens of the water that passed over the beds, and the specimens were taken by means of the drop-water cylinders at every two fathoms of depth. As soon as possible after securing them they were tested with the hydrometer. The results are tabulated in the "record of densities," and curves showing the various changes accompany this report. All densities are reduced to a standard temperature of 60° Fahr., and 1,000 represents the density of distilled water.

In studying these curves, it must be remembered that only their variations are of particular importance. The absolute density is not so much so, except for comparison with that of other localities; but the variations are important if by them we can account for the failure either of the propagation or attachment of the young oysters. The curves will show certain irregularities, due to either the variations in depth, or to the tides having changed from flood to ebb, or the reverse, on one side of the Sound at a time differing from that on the other.

As will be seen, however, the greatest variations in each month are in Tangier Sound, on the eastern side, where the influence of the rivers is felt to greatest extent. In Pocomoke Sound the greatest variations appear to be on the western side, and I assign as a reason for this that the influence of Guilford and Mesongo Creeks is of small importance compared with that of the Pocomoke River, the current from which sweeps along the northern and western parts of the Sound. The curves show that the variation is very slight, except on the September sections.

The second series of curves, those showing the monthly change of mean densities, indicate that the maximum change on each section was about the 1st of September; that the variations in Pocomoke Sound were much greater than in Tangier Sound; and that the maximum changes were at the head of each Sound, and the variations diminished towards the entrances.

The third series of curves shows the same when all the observations in each Sound are assembled, but with this difference—while the density in Tangier Sound was greater on October 1st than at any other time, in Pocomoke Sound the influence of the river was still felt; and notwithstanding the diminished temperature the density on the 1st of October was less than on the 1st of August.

The fourth series of curves shows the difference in density between the upper and lower sections in Tangier and Pocomoke Sounds in each month, and indicates that the density of the water is considerably greater over the lower beds than on the upper.

The maximum density found during the summer was on section 3, in October, and was 1 0166. The minimum density was found in section 5, in September, and was 1.0005.

By referring to the curves showing monthly changes of *mean* densities, it will be seen that in only one case, that of section 5, does the density become less than 1.0100, and that even on this section it is evident that this was not the normal condition of the water. There were heavy freshets in the Pocomoke River during the latter part of August and during September, which accounts for the slight density as shown by the curves. Mr. Barroll was informed by the inhabitants of the vicinity of the mouth of Pocomoke River that these freshets had killed large numbers of oysters, both on the natural and planted beds. An inspection of the other curves shows that the variation of density on successive tides was not much greater on this section than on the others, and as the oysters elsewhere in the Sounds did not appear to suffer from the effects of these variations, I am of the opinion that the fluctuation was not sufficient to affect the mature animal, but that in this case the water continued fresh, or practically so, for too long a period, thus killing the oysters by endosmose.

From the observations of density, then, it may be assumed that the density of the water, in these localities at least, cannot fall below 1.01 for any protracted period without destroying the oysters. Whether the changes in density affect the spatting can only be ascertained by continuing the observations for a number of seasons, or by direct experiment with the spat artificially raised.

INCIDENTAL INFORMATION.

During the summer I have examined, under the microscope, 374 oysters, of which 212 were females and 162 males, or the percentage of females was 0.56. The oysters were not all examined at the same time, nor were they all from the same bed, but the percentage in each of the lots examined, twelve in number, does not vary greatly from the percentage given above. I am of the opinion, therefore, that about 60 per cent. of the oysters in a community are females. A larger number of observations is, however, desirable.

In making these examinations I have never seen both ova and spermatozoa in the same animal, though I have made many careful observations in order to detect the presence of either. I have also carefully examined the gills and mantles of a large number, and have never found an embryo oyster within the shell; and as these observations were made during the spawning season, I do

not think it possible that the spat, if they are at any time contained within the gills or mantle, could have escaped my notice.

The observations as to the sex of the oyster were continued late in the season, and though the ova and spermatozoa in a number of oysters were in apparently good condition as late as the 1st of October, yet those products of generation appeared in best condition in the largest number of animals during July, and a considerable disintegration of the eggs was noticed by the end of that month. As far as I could ascertain, the condition of both ova and spermatozoa depended upon the depth of water, though the rule was not invariable. The generative products of the deep-water oysters reached a state most favorable for reproduction several weeks after the same had occurred in the shoal water; and, in general terms, neither ova nor spermatozoa in most of the oysters, in either deep or shoal water, after the middle of August, was in a state favorable for fertilization. Large numbers of oysters in all depths passed through the spawning season without expelling the contents of the generative organs. I found this the case especially on the beds on the western side of Tangier Sound, above Kedge's Strait, where, on the 8th and 9th of October, we found many oysters fattening with the generative matter unexpelled. I was informed that this was not unusual, and that it injured the oyster for marketable purposes. As late as the 8th I found oysters with the generative matter in good condition, and on the 7th of October I succeeded in securing from oysters taken from Kedge's Strait a sufficient amount of ova and spermatozoa to make experiments in artificial impregnation, and was successful in producing one embryo oyster. Probably had I used greater care a larger number would have resulted.

During the season of 1878 we observed large numbers of *astyris* in the shells of the mature oysters and attached to those of the young. In many cases they were found in the holes which had been bored in the shells of the latter. As we could not find any known enemy of the oyster in sufficient numbers to account for the evident damage done, and as so many circumstances pointed to *astyris* as the cause, I concluded that the boring must be done by that animal, and alluded to it in my previous report. The specimens preserved were described by Mr. W. H. Dall, and the description appended to that report. During the past summer we have found a much larger number of the rough welks (*urosalpinx cinereus*) than during the previous season, and though they were not found in as large numbers as the *astyris*, yet their presence inclined me to question the conclusions arrived at during the season of 1878. I accordingly collected a large number of *astyris* and placed them in an aquarium jar with a number of young oysters, changing the water constantly and inspecting the animals frequently. The observations were continued for over a week, and at the end of that time both oysters and *astyris* were alive, but there was no evidence of any boring, nor did any inspection show an inclination in that direction upon the part of the *astyris;* on the contrary, they soon left the shells and went to the bottom of the jar. I then collected a number of *urosalpinx cinereus* and subjected them to the same test. At the end of four days one oyster had been bored and one welk was found at work on the shell of another. The rough welk is known to do great injury to the oyster in Long Island Sound, and the destruction of the young, alluded to in my previous report as due to the drills, may be effected by this animal. That large numbers are destroyed by the welks cannot be doubted; but as it is possible that the *astyris* may also assist in this destruction, a more extended investigation of this question than I was enabled to make is desirable.

An analysis of several specimens of the water of the Sound and bay, by Prof. C. E. Monroe, of the Naval Academy, is appended to this report for use in comparing the localities investigated with others whose investigation may be subsequently attempted. The specimens have been selected from those taken on different stages of the tide and from different sections.

The only noticeable change on the beds this season was that the amount of red sponge appeared to be much less than in 1878. In other respects they are, to outward appearances, in a similar state, though the dredgers report them as much broken up and with an increased amount of *débris*.

INFORMATION OBTAINED FROM "RECORD OF STATISTICS."

The member of the party on duty at Crisfield inspected, during the season, 496 vessels directly engaged in the oyster fishery, and the results of these inspections have been recorded in the record of statistics, which record, to a great extent, explains itself.

Owing to the large number of vessels dredging, it was frequently impossible to visit and inspect all that entered during the day. When such was the case, those inspected were selected from different classes and from different dredging grounds that a fair idea might be obtained of the number of oysters removed each day from each bed.

The method of examination was as follows:

The total number of bushels in the load given by the master of the vessel was recorded, with the number of hours of labor necessary to obtain that quantity, and other matters of statistical interest. Several samples of one-quarter or one-half bushel each were then selected from different parts of the load and the number of oysters of each class in each sample counted and recorded. The number of samples examined depended upon the number of bushels in the load and upon the character of the oysters, a large number being taken when the oysters appeared dissimilar, and when the quantity was great. At least three samples were usually examined. In most cases the average number of each class per sample was nearly the same as that given by each examination, and, consequently, it is assumed that a close estimate of the number of each class in the entire load was obtained by multiplying the number of each class in a bushel, as shown by the samples, by the total number of bushels in the load. From the record of these inspections I have been able to determine with practical accuracy the number of oysters of the several classes removed from the various beds by each description of dredging vessel.

After September 1, when the dredging began, we counted each day all the vessels in sight from the "Palinurus," specifying the size and the ground upon which they were working, and the masters of the dredging vessels were also requested to note the number of dredgers working in their vicinity, which they in many cases very obligingly did. As even with these data, the number of working days given on each bed is very small, and because no bed is dredged continuously during the season, but at intervals, I have divided the sections in a similar manner to that described in my previous report.

The first section includes the beds north of Piney Island Bar and the Muscle Hole; the second section, those from the Muscle Hole and Piney Island Bar to the Great Rock; the third section, the remaining beds in Tangier Sound; and the fourth section, all the Pocomoke beds. By this arrangement duplication of the vessels counted is prevented and the average number of vessels working each day is more nearly a correct estimate.

The vessels dredging on these several sections, as counted by ourselves and by their masters, have been assembled; the number of oysters assigned to each class of vessel working in the section has then been multiplied by the number of vessels of each class, and the total number of oysters taken off the beds in each section thus obtained. The number of oysters taken by any vessel in a day varies greatly, owing to the weather principally, but in assigning the quantity on each day, the number brought in by vessels of the same class, as shown by "record of statistics," has been used, as a more correct estimate is thus assured than would be given by using the average for the whole season. The following table has been compiled from the calculations, and shows the number of oysters taken from each section in a specified number of days; supposing the observations to have extended over a sufficient period, the number of oysters has been divided by the number of days, and the average number removed in each day thus obtained.

Table showing estimated number of oysters removed in 1879.

SECTION 1.—UPPER TANGIER SOUND.

	Number of sail.	First class.	Second class.	Third class.	Fourth class.	First and second classes per sail.
Total number of oysters removed in 12 days	By 521 sail	2,322,200	1,934,200	1,382,500	371,000	8,100
Average per day		192,683	161,183	115,200	30,916	
Total first and second classes per day		353,866				

Table showing estimated number of oysters removed in 1879—Continued.

SECTION 2.—MIDDLE TANGIER SOUND.

	Number of sail.	First class.	Second class.	Third class.	Fourth class.	First and second classes per sail.
Total number of oysters removed in 17 days	By 634 sail	2,463,800	1,623,860	1,132,060	384,220	6,400
Average per day		144,929	95,521	66,591	22,600	
Total first and second classes per day		240,450				

SECTION 3.—LOWER TANGIER SOUND.

Total number of oysters removed in 34 days	By 951 sail	2,329,600	1,413,610	1,407,230	558,900	3,900
Average per day		68,223	41,576	41,389	16,438	
Total first and second classes per day		109,799				

SECTION 4.—POCOMOKE SOUND.

Total number of oysters removed in 9 days	By 169 sail	256,809	121,103	88,800	20,108	2,200
Average per day		28,534	13,567	9,866	2,234	
Total first and second classes per day		42,101				

Total number of oysters first and second classes removed in one day 746,226

It will be noticed that the number of dredging vessels increases on each succeeding section in Tangier Sound, but that the number taken by each sail, and the yield per day, decrease. Also, that the number of sail in Pocomoke Sound is much smaller than in any other section, and that the yield per day is also much smaller. The character of the bottom and the depth of the water materially influence the yield of the beds, those in shoal water with soft bottoms allowing more frequent hauls of the dredges than those in deep water or on hard bottoms. But as the dredges used in deep water and on hard bottoms are usually much heavier, this inequality is overcome to some extent. Again, the large vessels take a greater proportion of the oysters than the small ones, and those large vessels usually work on the deep-water beds. Considering the different sizes of the vessels and the superiority of the crews of the larger ones, and the heavier dredges used by them, I am of the opinion that the disparity between the yields of the Upper and Lower Tangier Beds is greater than it should be. The beds of the Middle Section are, with the exception of Piney Island Bar, similar to those of the upper section; yet, with a larger number of vessels working, the yield of that section is less than the upper. These facts, I think, show that the beds in Lower Tangier Sound are less productive than those in the upper.

The dredging in Pocomoke Sound was principally on the upper beds, and none was done as far as we could ascertain on either the Brig or Parker's Beds. As the middle and upper beds in this Sound are very similar in character of bottom and depth of water to the middle and upper beds in Tangier Sound, it would be inferred that the yield per day in Pocomoke would be about the same. On the contrary, as shown by the table, it is absurdly small; and, considering its size, it is not astonishing that the beds have been to a great extent abandoned.

Taking the number of oysters removed each day, and considering, for the reasons given in my previous report, the working season to be of 120 days, I have compiled the following table, in which is given the number of oysters removed from each section and from the Sounds in one day and in the season. I have also given the same estimated in 1878 for comparison.

Table showing the number of oysters removed.

Section.	In one day.		In one season.		Number of young growth, 1879.	
	1878.	1879.	1878.	1879.	Per day.	In the season.
No. 1	567, 450	353, 876	68, 094, 000	42, 465, 120	146, 100	17, 532, 000
No. 2	378, 450	240, 450	45, 414, 000	28, 854, 000	89, 200	10, 704, 000
No. 3	459, 000	109, 799	55, 080, 000	13, 175, 880	57, 800	6, 936, 000
No. 4	133, 650	42, 101	16, 038, 000	5, 052, 120	12, 100	1, 452, 000
All sections	1, 538, 550	746, 226	184, 626, 000	89, 547, 120	325, 200	36, 624, 000
Bushels	7, 692	3, 232	923, 230	447, 735		

Two hundred oysters are allowed to a bushel.

The estimated number of young removed from all sections in one day, in 1878, was about 1,240,000, or 148,800,000 in the course of the season.

It will be seen by the table that about one hundred million more oysters were removed in 1878 than would be in 1879, and that about the same excess exists with regard to the young. Of the two estimates, that of 1879 is much more accurate, being based upon a larger number of observations, more carefully and systematically made than was possible in 1878, but the disparity between the two is so great that the estimate of 1878 would appear valueless, could not some cause be assigned for a decrease in the number of oysters taken from the beds. This decrease, as may be easily seen, must be due to one or both of the following causes:

1st. The fertility of the beds remaining the same, the dredgers may not be as numerous.

2d. The number of dredgers remaining the same, the beds may be exhausted; or, becoming so, there would be a smaller number of oysters produced; or,

3d. The number of dredgers may have decreased and the fertility of the beds may be greatly impaired.

There are no statistics of the oyster fishery in the localities under consideration except those collected by myself, and I am consequently obliged to put a greater dependence upon them than they intrinsically merit. They are necessarily somewhat rude, but, in the absence of other information, they can be used as giving some indication of the probable progress of the fishery in the two seasons under consideration.

By examining my previous report it will be seen that in thirteen days we counted 1,595 vessels working on the various beds in both Sounds. From our records of the past season I find that the number observed by all persons was, in thirty-seven days, 2,275, or in 1878 the average number working on each day was 122, while in 1879 it was 61, or one-half as many. Therefore, the small yield of the beds during the autumn months of 1879, and the small estimate of the yield for the year, may be accounted for by the smaller number of vessels at work, and as in round numbers the number of oysters estimated as taken in 1879 was about one-half that in 1878, I think that the previous estimate may be accepted as practically correct.

My last advices from Crisfield inform me that there is but very little dredging going on in the Sounds, most of the vessels working in the bay and in the Potomac River. The principal cause assigned for this is the presence of young growth on the beds, by which is meant immature oysters under two years of age. The presence of this class in large numbers prevents the oysters from fattening rapidly. Another reason given is that the beds are much broken up, and that the returns are very poor for the usual amount of labor.

CONCLUSIONS.

My additional experience in the investigation and the information collected during the past season has proved that a few of the conclusions at which I arrived in 1878, and which are contained in my report of the operations of that season, are erroneous. Some of them have been already alluded to, and the allusions to the remaining ones here find their most appropriate place.

I find my supposition that there is a general attachment of spat on all the beds in any season, to be, to a certain extent, incorrect. The spatting may be general, and a majority of the

oysters may spawn each year, but the attachment of the young is a very different thing, and as the most precarious period in the life of the oyster is that just anterior to its attachment, a series of causes detrimental to the life of the embryo, while it is in its free swimming state, may readily occur, and thus prevent such attachment. My investigation of the past season has proved conclusively that the class of oysters termed "young growth" in my previous report were not of the brood of 1878 but of 1877 or 1876. The character of the young found in both seasons, the determination of the time of earliest attachment, and the growth and appearance of the oysters on the tiles, have led me to this conclusion. As the young do not attach before the middle of August, they could hardly reach such a size and shape by October as would prevent their recognition as of the same season's growth. From the inspection of the oysters taken during the last season, many being found with the generative matter unexpelled, I am of the opinion that a combination of natural causes may prevent the expulsion of both the male and female cells, and there would consequently be no impregnation during that season. As I mentioned in the report of 1878, many persons of experience are of that opinion, and I now concur with them in thinking that not only the attachment of young may not be general nor occur each year, but that the emission of the products of generation may also be frequently confined to partial areas, and that by a combination of circumstances there can be a total failure of impregnation on all beds of any locality.

I also find by additional experience, that the young oyster is not fit for marketable purposes until at least a year and a half or two years old, and consequently the total number of young removed, as estimated in my previous report, would be a total sacrifice, and, as will be seen by the table showing the number of oysters removed, this sacrifice probably amounted in 1878 to 148,800,000 oysters.

By reference to the tables showing the success or failure of the several spatting seasons, it will be seen that there is little or no regularity of either success or failure, but as we have only been able to investigate the spatting of three seasons, it may be found by subsequent observations that two similar seasons of success, moderate success, or failure, will follow each other; but so far this has not been the case and in the period of three years we have, comparatively to the other seasons, one at least of successful attachment. I can see no reason for supposing that there is any regular recurrence of the spatting seasons, and am inclined to believe that the success or failure is due to two causes: variations of temperature and variations of density; but I had no means of ascertaining the changes either of temperature or density in the years preceding those in which I have been engaged upon this investigation, and in both seasons I arrived in the Sounds too late for the temperatures or determinations of density obtained by the party to be, with reference to the spatting, of practical value.

Oysters will and do live in very dissimilar temperatures and in waters of very different densities, as is shown by their existence in the waters of North America from Nova Scotia to the Gulf, and on both Atlantic and Pacific coasts. That the mature oyster is a hardy animal, readily adapting itself to new conditions and environment, is shown by the ease with which it is transplanted from the warm waters of the Chesapeake to the colder ones of New England; from the dense and salt waters of the ocean and bay to the brackish waters of the creeks and rivers or vice versa, and from soft bottoms to hard or the reverse; but, naturally, this hardiness is not a quality of the immature oysters or the swimming embryos.

The influence of increased or diminished temperature upon the formation of the ova and spermatozoa must be very serious, and, judging by analogy, it would seem probable that the formation would be more rapid during a warm spring than during a cold one. Whether the formation has been late or early when once formed, a sudden change of density or of temperature may so affect the oyster or the generative matter that the latter would not be expelled. Only upon this hypothesis can be explained the retention of the products of generation noticed in so many oysters, and which is said to be so common, for none of the other conditions are subject to violent changes, such being peculiar to the density and temperature alone.

Professor Brooks states that he found both ova and spermatozoa ripe and fit for fertilization about the middle of May, and as the oysters were taken from shoal water, probably one fathom deep, the shoal-water oysters were probably spawning throughout June. Both Professor Brooks and myself found the ripeness of the oysters to depend upon the depth of water from which they

were taken, and this is without doubt caused by the difference of temperature. Professor Brooks also states that there was a great deal of cold, rainy weather during June, and two hail storms. The rainy weather would affect the density of the water by increasing the volumes of the various creeks and rivers, and the changes of density would probably affect the production and emission of the generative matter. It is an interesting coincidence at least, that the oysters found to be fattening with the products of generation unexpelled were either from beds in comparatively shoal water, or from the shoal parts of deep-water beds, and that those oysters should have been ripe and spawning during the month of June. Again, it may be that the lowness of the temperature prevented the deep-water oysters from ripening as soon as usual, and the mildness of the succeeding autumn may have prevented the destruction of the ova and spermatozoa, thus rendering possible the fertilization achieved by me in October, as the oysters from which I procured the ova and spermatozoa were taken from deep water.

Probably the influence of changes of environment, especially of density and temperature of the water, is most severely felt by the embryo when in their free swimming state, and, in connection with the want of success of the spatting season in the Sounds, it is noticed that the temperature curves show a maximum change about the time when it is supposed that the young would attach in largest numbers, or when they were swimming about in the water. It is also worthy of notice that Professor Brooks, about this time, met with the minimum amount of success in his efforts to artificially raise the embryo.

In consideration of the foregoing, I am of the opinion that the success or failure of any spatting season is dependent upon the equability of the temperature; that the higher the temperature during the spring months the earlier will be the advent of the spawning season, and that an increased temperature will also hasten the development of the spat, and of the young oysters after they have become attached. I also infer that sudden and extensive changes of density will likewise affect the advent, duration, and success of the spawning, though to a less extent. Subsequent to the attachment of the animal, changes of the conditions surrounding it are not of so much importance, though naturally such changes will more severely affect the delicate organism of the young oyster than that of the older and more hardened adult.

During the first six months of its existence the oyster is exposed to the greatest danger from the numerous enemies which surround it. The thin, delicate shells, from one-sixteenth of an inch to one inch in diameter, are readily bored by the drills or torn off by the crabs, and the immense number of both leaves no room to doubt their destructive effects. As an instance, the inspection of the spat collectors in the Big Annemessex River shows that during the early months of their existence about 50 per cent. of the young oysters were destroyed. Naturally, as the animal progresses, it becomes more hardy and better able to resist the attacks of enemies and changes of environment, and thus we find on the unworked beds, where the oysters are practically in a natural state, that the decrease in passing from young growth to mature oysters is about 30 per cent., or about one-third of a given number perish in passing from the first to the fourth year of their existence.

Here our information ceases, but enough has been gathered to indicate the ratio which nature has assigned as necessary between the young and the mature oysters. For every 1,000 of the latter there should be 1,500 of the former, if the number of brood oysters necessary to maintain the fecundity of the beds is to be kept up, and though this ratio is based upon *data* which are not quite sufficient, yet, as I have said, it is all that has been afforded as yet, and may be accepted within certain limits. Certainly, whatever it should be, the number of the rising generation of the animals should never be less than that of the older, or there should always be as many young as mature on any bed, and a greatly increased ratio of young to mature oysters would show either one of two things—either the mortality in passing from youth to maturity was much greater than shown by the dredging results in the bay, or that a very large number of mature oysters had been removed by other than natural causes.

In considering these several beds the question of food and other necessary supplies has not been considered, as it is evident that where an oyster bed is formed and exists naturally, all the conditions for its successful life are probably present, and any failure of an important supply would be followed by a speedy extinction of all the oysters on the bed. Such determinations of the quality

and quantity of the food, character of bottom and water, and other matters, are only of interest and desirable for the purpose of comparing one locality with another. Such was not the purpose of this investigation, and consequently the determination of those points has been but incidental to the work.

Probably the fecundity of a bed is increased, to a certain extent, by working upon it. The dredges or other implements used open the bed and spread it, thus giving more room for development, and allowing a greater amount of food to reach the animals, and as the mortality is great in all thickly-populated tracts and in any closely-united community, it is evident that no removal of brood oysters could be effected without destroying the fecundity of the bed, did not this very removal influence the mortality among the young so as to allow a larger number to come to maturity. But the removal of brood oysters may become so great that the most violent exertions of nature to supply others are unequal to the demand, and it must be evident that as soon as the number of brood oysters is thus diminished, the fecundity of the bed is impaired.

This impairment constantly increases, influencing, as it does, both old and young. As the number of the latter decrease, so will the number of the former, and as that number is again and again diminished, the number of young produced by them must constantly diminish. Thus the cause for the destruction of the fecundity of the bed and the gradual extinction of the animals upon it can be readily understood and as easily comprehended as the fact that the fecundity or productive power of a bed depends upon the number of mature spawn-bearing oysters upon it. It is not meant by this that none but the mature oysters are capable of reproduction, as such is not the case, oysters of even six or nine months' growth having been observed by me with ripe ova and spermatozoa in them, but the main dependence must be placed upon the adults in the community, as the spawn of the young growth is not considerable when compared with that of the other class.

Without a knowledge of the number of oysters on a bed it is impossible to say what number should be removed, and as an attainment of the knowledge of the number on the bed is almost impossible, all that can be done is to keep the ratios between the young and the mature as nearly the same as on the natural beds; this should be the aim and result of all laws having the protection of the beds in view.

Referring to that portion of this report relating to the fecundity of the beds in the Sounds, it is seen that in some cases the ratio of young to mature oysters is greater, and in other cases less, than it should be, and that in a few cases the ratio seems to be within the prescribed limits. As has been shown, the decreased ratios must be the result of a want of reproduction, while the increase may be due to the removal of the mature oysters.

If we take the total number of the oysters examined in the Sounds we will have a ratio expressing the general fecundity of the beds, and this ratio between 70,866 mature oysters and 36,824 young ones is 0.5. Assembling all the oysters counted on the beds in the bay we would have as a ratio 1.5.

Practically, none of the mature oysters had been removed from the beds in the bay, while large numbers had been taken from those in the Sounds. The estimates for each show, approximately, how many have been taken, and if by examination we find that the number of young oysters taken off the beds in the Sounds greatly exceeds the number of mature removed, it may be assumed that the restoration of both classes to the beds would be immediately shown by a change in the ratio of young growth to mature oysters. By the estimate of 1878 we find that 184,600,000 mature and 148,800,000 young were removed, but as the number of young removed would be less and less during the season on account of the mortality among them, and as we have found that mortality to be about 50 per cent., I will consider that the removal of the young during the season of 1878 and 1879 probably did not exceed 74,400,000. Therefore the total number removed was 259,000,000, of which 71 per cent. were mature, spawn-bearing oysters, and as 65 per cent. of the oysters at present on the beds are mature, the addition of the 260,000,000 removed would raise this percentage to 68, which would make the ratio of young to old even smaller. Consequently the small percentage of young is not due to the removal of that class during the previous season.

The two beds of which we have the most exact and complete statistical records in this season

are the Woman's Marsh and the Great Rock, and, by means of the record of statistics, I estimate that the following number of oysters have been removed from them:

Table showing number of oysters removed from Great Rock and Woman's Marsh.

Name of bed.	Removed in a year.		Total both classes.	Percentage of mature.
	Mature.	Young.		
Great Rock	10, 176, 000	5, 640, 000	15, 816, 000	64
Woman's Marsh	1, 740, 000	768, 000	2, 508, 000	69

From Table II, dredging results in the Sounds, I find the percentage of mature oysters to the total number on the two beds mentioned is on the Great Rock 24, and on the Woman's Marsh 36. Hence, if there had been no fishing, we would have on the Great Rock 44 per cent. of the oysters mature and full grown, and on the Woman's Marsh 52 per cent. mature. We find by making a similar calculation for Piney Island Bar that the percentage of mature oysters removed is 70, and that by the dredging results 20 per cent. of those on the bed were mature; hence, 45 per cent. would represent the percentage on Piney Island Bar had there been no fishing. The ratios on these beds would then, were the oysters removed still present, be 1.2 on the Great Rock, 0.9 on the Woman's Marsh, and 1.2 on Piney Island Bar.

It will be seen by the above that there has been a severe fishing of many of the beds in the Sounds during the last four or five years—that is, exhaustive of mature brood oysters—and that consequently the large ratios of young to mature oysters is not the result of a large attachment of young, but rather of the removal of the older oysters, and hence the change from a large ratio to a very small one, or *vice versa*, may be regarded as a safe indication of the deterioration of the bed; for, as explained in the previous part of this report, the ratio will remain abnormally large until the young growth reach maturity, when it will become abnormally small, and will so remain for a few years, when it will again become very large, and this process will continue for some time until the beds are practically unfit for dredging, as is the case in Pocomoke Sound. Thus not even the ratios are sure indications of the increase or decrease in the number of oysters, but they must be considered together with other facts before we can arrive at just conclusions.

By reference to the closing paragraphs of that part of the report relating to the fecundity of the beds, it will be noticed that the amount of *débris* increases on the southern Tangier beds, and that on most of the beds of the Sounds it is much greater than it was in the bay. An increase of the percentage of *débris*, as already pointed out, is an indication of the deterioration of the bed, and is due to the destructive effects of the dredging, which not only removes many oysters, but so disturbs many others that their destruction is an almost assured fact. To a certain extent this is a necessary incident of the fishery, and cannot be helped; but overworking the beds increases this evil as well as others, as is evident by the percentage on many of the Pocomoke beds.

Referring to the table showing the number of oysters removed in 1878, and comparing it with the table of number of oysters to the square yard, the following may be noticed:

1st. In the upper part of Tangier Sound the numbers to the square yard are very large, which is probably due to the shoalness of the water and the soft bottom, which allowed a larger number of oysters to be taken. In addition, the mature oysters are smaller than on the southern beds, as shown in Table I, dredging results; thus a greater number would be taken in the dredge, and the number to the square yard increased.

2d. Though the numbers to the square yard are very large, yet there is a serious decrease from that established in 1878.

By reference to the "Table showing number of oysters removed," I find that the largest number of oysters were removed from this section in both seasons, and, supposing the number of dredging vessels to have been constant, instead of diminishing one-half, the number of oysters removed in 1879 would be greater by 14,000,000 than the number removed in 1878, or, in other words, the fishing is proportionally increasing. As this fishing is confined principally to the

mature oysters, it can be readily understood why the number of these oysters to the square yard should be much decreased.

In the second section we find the numbers to be nearly the same as those outside; that there is a gain in the rivers where there is the minimum amount of dredging, and also on two beds which were worked very little in 1878–'79, on account of the young growth which had attached to them. The proportional increase of dredging, as shown by the numbers removed in each season, and supposing the number of dredging vessels to have been the same, would be, on this section, 11,000,000; these were taken principally from the western beds and Piney Island Bar, and on those beds there is a diminished number to the square yard.

Again, we find by reference to the tables, that on the southern beds in Tangier Sound the number to the square yard is much smaller than on the beds in the bay. This is due probably to two causes—the condition of the bed, or the depth of the water, hardness of bottom and size of the oysters, and to the removal of too large a number of mature oysters during previous years. As I have pointed out, where the number on a worked bed falls much below that on an unworked one, it must, other things being equal, be accepted as an indication of a decrease in the productivity of the bed. That much is assured; but on this section there appears to be an increase in the number of oysters to the square yard over the number found in 1878, and that increase must be accounted for in some way.

The table showing the number of oysters removed proves the number taken from this section to be a constantly decreasing one, for in 1878 there were taken by twice as many vessels four times as many oysters as were removed in 1879. This may be due to two causes, and probably is due, to some extent, to both. The productivity of the beds may be impaired, or the fishery may be less earnest and exhaustive than in the past. We can only account for the increased number to the square yard by assuming the latter to be the case, the beds having probably enforced a resting period by the material failure of the oysters.

The numbers to the square yard and yield in Pocomoke Sound need no comment. Not only are the numbers below the standard and decreasing, but the yield is also decreasing, as it naturally would under such circumstances.

Naturally, as soon as any bed ceases to give an adequate return for the labor expended upon it, the dredging vessels will seek other and more profitable fields for exertion, and the desertion of any bed may be accepted as an indication of its decreased productive power. As has been mentioned under the head of statistical information, dredging vessels have, to a great extent, left the Sounds for the waters of the bay and Potomac River.

Considering the abnormal ratios between the mature and young oysters, the increased percentage of *débris* on the beds, the smallness of the number to the square yard, and the decrease of those numbers on most of the beds, together with the large number of oysters, young and old, annually removed, I am of the opinion that though the fecundity of the beds in Tangier Sound is not yet destroyed, it is very much impaired, and that not only are the beds rapidly and surely deteriorating from the excessive fishery, but that their total failure, like unto that in Pocomoke Sound, is but a question of time.

So far as it is possible to make any more exact prediction than the above, I am of the opinion that, the fishery still continuing, this failure will occur first on the beds at the entrances of the Sound or those in sections 1 and 3, and of the two the failure of the lower beds is most likely to first occur, and of all the beds the Woman's Marsh will be the first to give out.

As stated at the beginning of this report, the beds may be protected either indirectly by enlarging the areas for the dredgers or insuring by artificial means the maturity of a larger number of spat; or directly, by limiting and restricting the fishery. I alluded in my previous report to the manner in which this latter form of protection was afforded abroad, and suggested a manner for affording it at home. The necessity for the adoption of some such measures seems so urgent that I earnestly hope they will shortly be undertaken.

The extension of the dredging ground can be easily attained by depositing the shells from the shell heaps about the packing houses on the bottoms contiguous to the natural beds; but such deposit should always be made in the direction of the ebb and flow of the tide, in order that the drifting spat may be carried over the newly-exposed cultch. The bottom is of minor importance

so long as it is of sufficient consistency to prevent the oysters from sinking into the mud. A sticky clay bottom is preferable, though the beds may be extended over sand shoals.

In searching for new beds they will probably be found about the mouths of estuaries and rivers, and where there are sudden changes of bottom. In the Chesapeake, depths of from two to four fathoms will be most likely to reward a search, and where there are large beds in the creeks and rivers it is likely that there has been a natural expansion through their mouths, and beds will probably be found off of them. The search must be carefully conducted, or the beds, which appear to be long, narrow ridges, will be missed. The dredge should be dragged across the tide, as the beds usually extend in the direction of the current. A sudden change of depth of two or three feet, and from soft to hard bottom when on an oyster ground, is an unfailing sign of the presence of a patch or bed.

Considering the success which has attended the investigation of Professor Brooks, and the new light which it has thrown upon the embryo life of the oyster, I think that perhaps the most efficacious means of maintaining the productive power of the beds would be in bringing, if such be possible, the artificial impregnation of the eggs and subsequent care of the young to such a state of perfection as would be of practical utility. Professor Brooks is, of course, the best person to devise the method of successfully continuing his experiment, and I hope that he may be able to do so and that he will meet with complete success. As pertinent to his work, which is mainly conducted by means of aquaria, I would suggest that the study of the effect of changes of temperature, so far as they affect the embryo, can be best and most easily done while engaged upon the attempt to artificially raise them; or, in order to arrive at certain conclusions with regard to the effect of changes of density or of temperature, the investigation, if conducted on the natural beds, must be extended over many seasons in order to insure, by a coincidence of temperatures or densities and results, the elimination of other affecting conditions. The study of the temperature seems so important that any suggestion with regard to it is of value and should claim attention.

I would also recommend that some person inspect and count, at intervals, the oysters on the spat collector in the Big Annemessex River. It is securely moored and buoyed with a spar buoy, and probably will remain in place.

With regard to the direct protection of the beds in the Sounds, I can only renew my previous recommendations.

The deterioration of any bed will be evident by an abnormal ratio of young growth to mature oysters; by a small and decreasing number to the square yard; by large and increasing percentage of broken shells and other *débris*, and by the appearance of the oysters, as has been described.

When all these indications are present, if the dredging is not totally prohibited it should at least be so limited as to insure the number of young growth remaining at least one third greater than the number of mature, and great changes from this ratio are to be avoided and guarded against.

APPENDIX A.

Areas of oyster beds.

	Square yards.
Fishing Bay Beds (solid)	3,600,000
Fishing Bay Beds (scattered)	25,605,000
Were Point (solid)	1,845,000
Shark's Fin (solid)	1,867,000
Nanticoke (solid)	3,465,000
Clump Point (solid)	382,000
Horsey's Bar (solid)	202,000
Tyler's (solid)	675,000
Drumming Shoal (solid)	2,430,000
Cow and Calf (solid)	292,000
Bed east of Bloodsworth Island (solid)	4,027,000
Cedar (solid)	337,000
Turtle Egg Island (solid)	1,620,000
Mud (solid)	1,845 000

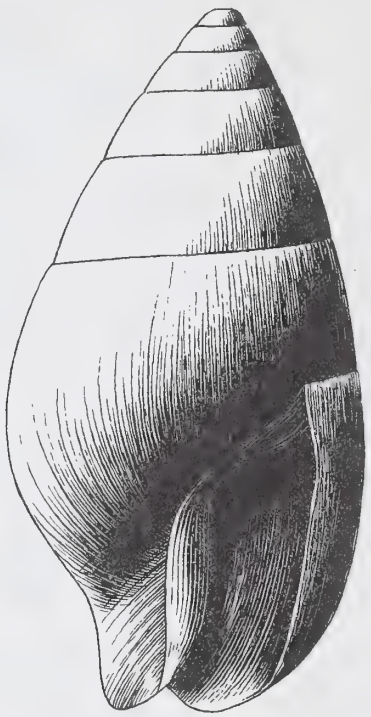
Areas of oyster beds—Continued.

	Square yards.
Chain Shoal (solid)	1,192,000
Muscle Hole (solid)	3,060,000
Piney Island Bar (solid)	6,975,000
Manokin River bed (solid)	6,142,000
Big Annemessex (solid)	2,835,000
Harris' (solid)	3,420,000
Terrapin Sands (solid)	1,417,000
Paul's (solid)	765,000
Woman's Marsh (solid)	6,975,000
Bed off Jane's Island Light (solid)	1,800,000
Great Rock (solid)	8,505,000
Little Thoroughfare (solid)	720,000
Great Thoroughfare (solid)	1,597,000
Oak Hammock (solid)	630,000
California (solid)	3,915,000
Johnson's (solid)	1,395,000
Brig (solid)	517,000
Parker's (solid)	495,000
Beach Island (solid)	225,000
Hern Island (solid)	2,092,000
Bird (solid)	3,285,000
Guilford Creek (solid)	1,642,000
Messongo (solid)	180,000
Muddy Marsh (solid)	1,912,000
Buoy Spit (solid)	427,000
Small bed south of Shell Bed (solid)	225,000
Shell (solid)	877,000
Trevise (solid)	697,000
Drum Bay Point (solid)	337,000
Dog-Fish (solid)	720,000
Flat (solid)	742,000
Small bed north of Trevise (solid)	135,000
Slate Stone (solid)	967,000
Potter's (solid)	900,000
New Plantation (solid)	180,000
Buoy (solid)	967,000
Old Rocks (solid)	1,057,000

TANGIER AND POCOMOKE—SUMMARY.

Total area in both Sounds occupied by oysters	425,012,000
Total area in both Sounds occupied by solid oyster beds	92,520,000
Ordinarily scattered	313,345,000
Thinly scattered	19,147,000
	Nautical square miles.
Tangier Sound (solid)	17.101
Tangier Sound (scattered)	44.926
Pocomoke Sound (solid)	4.519
Pocomoke Sound (scattered)	29.599
Fishing Bay (solid)	0.875
Fishing Bay (scattered)	6.225
Total area both Sounds covered by oysters, or scattered oysters, in *square miles* (nautical)	103.255

NOTE.—Those areas designated as "solid" are those where the number to the square yard was above 0.1, or more than one oyster to ten square yards.



ASTYRIS: variety WINSLOVII

CHESAPEAKE BAY, NEAR CRISFIELD, MD.

Reported to be injurious to young oysters

SCALE: $\frac{20}{1}$

APPENDIX B.

DESCRIPTION OF THE "DRILL" REFERRED TO IN THE REPORT OF THE OPERATIONS DURING THE SEASON OF 1878.

By W. H. Dall, Asst. C. & G. Survey.

Only a few specimens were preserved, and hence it is impossible to speak positively in regard to its distinctness from the allied forms *Astyris spizantha* (Rav.) and *A. lunata* Dall (Ex. Say).

It differs from the former, so far as the specimens go, in color, pattern, and solidity, having also more whorls and a more slender form.

It differs in form very much from southern specimens of *A. lunata*, but more specimens of each are needed to determine the limits of variation in these small shells. They belong to a group known to be extremely variable.

It may for the present be denominated by the varietal name *Astyris* var. *Winslovii* in commemoration of its discoverer.

Though known to be carnivorous, no species of the genus *Astyris* has been recorded until now as an injurious animal.

APPENDIX C.

Table showing number and class of dredging vessels seen from the Palinurus during the season of 1878.

Date of observation.	Number of sail.	Class.	Ground on which at work.	Number of bushels.	Number of young.
1878.					
Sept. 18	57	2	Pocomoke Sound	946	
19	43	2	do	714	
20	51	1	Southern part Tangier Sound	2,142	432,684
20	61	2	Pocomoke Sound	1,013	
23	123	1	Southern part Tangier Sound	5,166	1,043,532
25	85	1	do	3,570	721,140
26	104	1	do	4,368	882,336
29	65	1	Middle part Tangier Sound	2,730	551,460
30	20	2	Manokin River	332	
Oct. 1	37	1	On the "Great Rock"	1,554	313,908
3	26	1	On Harris' Bed	1,092	220,584
3	20	1	On Terrapin Sands	840	169,680
3	16	2	On Muscle Hole	266	53,732
3	14	1	On Piney Island Bar	588	118,776
3	25	2	Manokin River	415	
3	63	2	On and above Chain Shoal	1,046	
4	115	2	Above Diel's Island	1,909	
4	17	2	On Muscle Hole Bed	282	56,964
4	6	1	On Terrapin Sands	252	50,904
4	30	1	Southern part Tangier Sound	1,260	254,520
4	79	1	Harris' Bed and Manokin River	3,318	670,236
4	112	2	North of Little Island	1,859	
7	210	3	Upper Tangier Sound	6,090	
14	210	3	do	6,090	

The classification of the dredging vessels is the result of, and dependent upon, actual observations. It was noticed that those vessels usually at work in a particular locality were generally of a certain rig and tonnage, and where there was a dissimilarity in that respect, we recorded, when in the locality, the proportion of large and small vessels and of different rigs. In compiling the table the dredging vessels have been separated into three classes.

The first class represents *large and small* vessels; the average "take" of this class was 42 bushels per vessel.

The second class represents *small* vessels; the average "take" of this class was 16.6 bushels per vessel.

In the third class, two-thirds of the vessels were *small* and one-third *large;* the average "take" of this class was 29 bushels to the vessel.

By actual count, we found the average number of young to a bushel to be 202.

APPENDIX D.

With the assistance of Mr. H. J. Rice, the following interrogatories were prepared and used during the season. The information obtained from the oystermen, which has been incorporated in the previous pages, is the result of the answers to the questions.

NAME AND LOCALITY OF OYSTERMAN.

1. Please state your name and your P. O. address.
2. In what place or places do you take oysters?
3. How long have you been engaged in the business?

THE BEDS: THEIR LOCALITY, CONDITION, &c.

4. Please give the location and the names of the beds in your neighborhood with which you are acquainted.
5. What is about the size of each bed?
6. On what kind of bottom are these oyster-beds generally formed?
7. Is this bottom subject to change in any manner?
8. What are the causes of such change or changes?
9. Does mud or sediment ever accumulate upon the beds?
10. Is it injurious in any manner to the oysters?
11. From whence does it come?
12. Can such deposit be prevented?
13. State average depth of water where these beds are found.
14. State the greatest and least depths.
15. Are the largest and best beds found near by, or distant from, the channels?
16. Does a change of channel affect them in any manner?
17. Has there been any change in any of the channels in your vicinity?
18. Have such changes, if any, affected the beds; and, if so, how?
19. What is the direction and amount of current over these beds?
20. Do you know of any beds that are "running out;" if so, how and from what causes?
21. Where are these beds?
22. Do you know of beds which are improving in any manner; if so, in what does this improvement consist? What is the cause of this improvement?
23. What is the general direction of the gales which are prevalent here in winter?
24. What in summer?
25. Which of these gales increase, and which decrease, the depth of the water over the beds?
26. Do the gales in winter affect the ice-fields in any manner; and, if so, how?
27. Do they ever seriously affect the beds, or change the neighboring shores; if so, in what manner, and to what extent?
28. If the water should be blown off from any of the beds during such gales would it injure them?
29. How long can the beds remain uncovered without injury?
30. How long have you ever known any to remain uncovered?
31. Is this a common occurrence?
32. Is ice ever piled up on the beds during such times, and on what beds?
33. For how long?
34. Has this piling up of ice any injurious effect upon them; and if so, what effect?

35. What thickness of ice do you generally find over the beds?

36. Does an increased thickness of ice affect the beds either in deep or shallow water; and, if so, what is the effect?

37. Is it greater or less in deep than in shallow water?

38. Does long continued cold weather affect them?

39. Is the effect greater in shoal or deep water?

40. During such cold spells does the ice ever rest upon the beds; and, if so, what is the effect?

THE OYSTER ON THE BEDS.

41. Are the oysters in your locality found mostly in large or small compact beds, or scattered over a great extent of surface and lying far apart?

42. How does their quality compare, as far as you know, with those of other localities?

43. Are they with you better flavored inside or outside of the Sounds and rivers?

44. Are they affected in any manner by long continued dry or wet weather?

45. What is the effect, if any, of long continued dry weather?

46. What is the effect of a large amount of fresh water pouring over the beds?

47. Do the oysters grow better in deep or shallow water?

48. Are they found in the channels, or where there is mud?

49. Have the oysters in your locality any particular enemies?

50. What are their enemies?

51. How destructive are these enemies to the oysters, and in what way?

52. Are there any means of destroying these enemies without incurring too great expense, or injuring the oysters, and what are such means?

53. Do you know the nature of the oyster's food, and what is such food?

54. Does it feed at any particular time, and what is such time?

55. What is the length of time it is occupied in feeding?

56. Will freezing kill the oysters of a bed?

57. If so, how long must they be frozen before they are destroyed?

58. Which of the beds in your locality produce the finest-flavored oysters?

59. How large do the oysters grow in your locality?

60. Do some of the beds produce larger oysters than others?

61. If so, which ones?

62. What causes this?

63. As far as you are aware, what is the greatest size which oysters will attain under natural conditions?

64. Are oysters attached to any objects, or to each other, or do they grow up separately and flat on the bottom?

65. At what time of the year do oysters spawn in your neighborhood?

66. Is there any difference in the sex of oysters, or are they hermaphrodites?

67. What are your reasons for thinking so?

68. If they are of different sexes, can you distinguish the male from the female before being taken from the shell, and how?

69. Is there any change in shape or color in either sex during the breeding season; if so, what is such change?

70. Is there any change at any other time?

71. At what age does the female commence to breed?

72. At what age does the male?

73. Is there any age after which oysters do not breed?

74. At what age do oysters produce the most young?

75. How do you know this?

76. Does the act of spawning seem to affect oysters injuriously in any manner; if so, how?

77. Do all the oysters of a bed spawn at or near the same time?

78. Have you ever seen young oysters floating or moving about in the water?

79. If so, were they in considerable numbers?

80. Is there any marked difference in the time of appearance of the young in different years?

81. Are the young especially liable to be destroyed?

82. If so, by what?

83. Can this destruction, if any, be prevented; and, if so, by what means?

84. What is the average growth of an oyster during the first year?

85. Have you ever known any disease to attack the oyster whereby great numbers were destroyed or rendered unfit for use?

86. If so, is such disease common, and at what times does it attack the oysters? What is the common local name of the disease?

87. What are the supposed causes of such disease?

88. Are about the same number of young found each year upon each bed?

89. Do some beds produce young some years and not others; and during these resting years do other beds produce young, and then rest in their turn?

90. Do all the beds rest periodically and at the same time?

91. Do currents or unusual conditions of the water appear to have any effect upon the time of spawning?

THE WORKING AND CULTIVATION OF THE OYSTER.

92. In your neighborhood how are the oysters taken from the beds—with dredges or tongs?

93. Does it improve or injure a bed to work it over with tongs or dredge?

94. Which of these two implements should be used for the best interests of the beds?

95. Are any beds improved by the use of one and not of the other; if so, of which?

96. Does the depth of water make any difference?

97. What kind of boats do you use in oystering?

98. After the oysters have been taken from the bed are they immediately culled, or do you wait until the fishing is over; and are they culled on their beds?

99. Are the small oysters thrown back or not?

100. What is the size of the smallest which are kept?

101. For the best interests of the beds, what proportion of oysters should be taken off each year?

102. So far as you know, or can judge, what proportions are taken from the different beds in your locality?

103. Is there a limit to the thickness of the layer of living oysters upon a bed; if so, what is such limit?

104. About what is the average thickness?

105. Should a bed be allowed to rest for certain definite periods?

106. If so, how long?

107. Will oysters fatten best upon the same beds upon which they are produced?

108. If not, what is the character of the bottom upon which they will fatten best?

109. Are oysters planted to any great extent in your vicinity?

110. What kind of oysters are best to use as plants, or does it make any difference which are used?

111. At what time are they taken up to plant?

112. At what age?

113. How are they taken—with dredge or tongs—and which is preferred?

114. Are they injured at all by rough handling, either for market or for planting?

115. What kind of places are most suitable for planting beds?

116. Do oysters breed on planted beds?

117. If so, do the young oysters thrive as well as on the natural beds?

118. If not, why?

119. Are oysters taken from your locality to other places to plant?

120. If so, where?

121. About how small are the oysters in your neighborhood when they first spawn?

122. Is there any difference in this respect, or in the time of year when they spawn, between those on the natural and those on the planted beds?

123. Does a wet or dry season affect the time of spawning, or the coming to maturity of the spawn?

124. Is there any difference as to the amount of young growth found on the beds in different years?

125. What is the reason for this?

126. Have any means ever been tried in your locality to propagate the oyster by artificial means other than by planting; if so, what means?

127. Do you ever attempt to increase the amount of "cultch," or objects upon which the young can become attached, by placing old shells or other rough substances in the water upon the beds?

128. Is there any law for the protection of oysters in your locality; if so, please give reference to date of law?

129. If so, is it carried out?

130. Are there any means by which protection is afforded to the oyster, to allow them to increase upon the beds, other than such law, if this exist?

131. Do the oystermen try to uphold all laws and all methods for the protection and increase of the oysters?

132. What is your method of fishing for oysters—with tongs or dredge?

OYSTER ECONOMY.

133. At what age are the oysters upon the beds in your locality best for market purposes?

134. What size are they at that age?

135. Do the oystermen try and select only such oysters from the beds, or do they take everything that will sell?

136. What is the size of the smallest marketable oysters?

137. How old are they?

138. Are oysters divided into classes according to their market value?

139. If so, what are these classes, and how recognized?

140. Do oysters from particular beds command better prices than those from other beds near by?

141. If so, what are the names of the preferred beds?

142. What is considered a profitable day's work with a dredge?

143. Can you catch that number now?

144. What kind of a boat, and how many men are employed with a dredge?

145. What is the size of the dredge?

146. In what depth of water can it be used most profitably?

147. Do all the men on board a dredging-boat share in what is taken, or are they paid regular wages?

148. If paid regular wages, how much per day?

149. What is considered a profitable day's work with the tongs?

150. Can you catch that number now?

151. In what depth of water can the tongs be used most profitably?

152. Do oystermen fish exclusively for any one grade of oysters, such as those which will do for barreling, or for canning, or do they catch promiscuously all and everything?

153. What kind of a boat is used in tonging, and how many men in each boat?

154. Which is most profitable, to tong or dredge exclusively?

155. If dredging is injurious to the beds, is it more or less so in deep than in shallow water?

156. Why?

157. Would it not be most profitable to catch one grade of oysters exclusively, and that the first grade?

158. Is a very fat oyster more profitable for barreling, or for canning, than one not very fat?

159. Are oysters sold by the load or by measure?

160. What is the price paid at present time?

161. What is the highest price you have ever received for oysters?

162. What is the lowest?

163. When was this?

164. What do you consider a profitable price for oysters?

165. Can an oysterman catch as many to-day, in the same number of hours fishing, as he could when you first began to fish?

166. What is the reason for the difference in the catch?

167. How many could one catch at that time?

168. What was the price then?

169. Does the price vary on account of flavor or fatness?

170. If so, which commands the better price?

171. To what market do your oysters go?

172. Do the oystermen dispose of their catch to the dealers or to traders?

173. How long can oysters be carried in an oyster vessel without injury?

174. In what shape can they be carried best?

175. Must any particular care be taken when transporting them?

176. About how many persons are engaged in oystering in your neighborhood?

177. How many vessels do they employ?

178. From your experience, what do you consider would be the best means of improving the beds and the quality of the oysters in your vicinity, for the best interests of the oystermen and of the general public?

FOR THE OYSTER PACKERS.

179. In what shape do you put up oysters?

180. What is your process?

181. About how many do you put up in a season?

182. From what part of the country do you procure your oysters?

183. What do you pay per measure or load?

184. How many oysters are there in a load?

185. Where are most of your oysters sent?

186. With barrel oysters is there any particular manner of packing them in a barrel?

187. Can you give any information from your books as to the number of bushels purchased and the number of gallons obtained from them each year?

APPENDIX E.

The following analysis of the water of the Sounds and Bay was made at my request by Mr. Charles E. Monroe, Professor of Chemistry at the United States Naval Academy. As in all probability the chemical character of the water in the locality under consideration is not subject to frequent or great changes the constituents of the water as determined by Professor Monroe may be accepted as the normal ones.

The analysis furnishes data for comparison, and in transplanting oysters from this locality it will be of advantage to the oyster culturist to consult the table and avoid the transference of the oysters to conditions of marked dissimilarity.

ANALYSIS OF WATER FROM TANGIER AND POCOMOKE SOUNDS AND CHESAPEAKE BAY.

By C. E. MONROE, *Professor of Chemistry, U. S. Naval Academy.*

Locality.	Total solids at 120°.		Chlorine.		Sulphuric acid.	
	Separate determination.	Mean.	Separate determination.	Mean.	Separate determination.	Mean.
Section 1, Station C—						
High water	18,000	18,000	9,370	9,390	1,532.6	1,525.3
	18,000		9,400		1,518.0	
Low water	17,340	17,339	9,080	9,090	1,507.8	1,482.4
	17,338		9,100		1,457.0	

Analysis of water from Tangier and Pocomoke Sounds and Chesapeake Bay—Continued.

Locality.	Total solids at 120°.		Chlorine.		Sulphuric acid.	
	Separate determination.	Mean.	Separate determination.	Mean.	Separate determination.	Mean.
Section 2, Station E—						
High water	20,904	20,852	10,820	10,830	1,708.4	1,701.6
	20,800		10,840		1,694.8	
Low water	19,850	19,845	10,460	10,480	1,662.8	1,654.1
	19,830		10,500		1,645.6	
Section 3, Station B—						
High water	23,118	23,120	11,880	11,900	1,948.2	1,948.2
	23,122		11,920		Lost.	
Low water	23,568	23,511	12,020	12,060	1,995.6	1,995.1
	23,454		12,100		1,994.6	
Section 3, Station F—						
High water, A	23,200	23,262	12,120	12,100	1,960.0	1,960.0
	23,324		12,080		Lost.	
High water, B	23,670	23,674	12,160	12,180	2,002.0	2,004.0
	23,678		12,200		2,006.0	
Section 4, Station C—						
High water	23,200	23,190	12,080	12,020	1,952.8	1,954.1
	23,180		11,960		1,955.4	
Low water	22,210	22,224	11,680	11,700	1,923.2	1,872.
	22,238		11,720		1,822.4	
Chesapeake Bay—						
Stations 18 and 19, bottom water	18,306	18,358	9,800	9,780	1,578.0	1,595.8
	18,410		9,760		1,541.6	
Atlantic Ocean—						
Latitude 41.18 N., longitude 36.28 W	.....	38,400	.....	20,839	.....	3,029.8

NOTE BY PROFESSOR MONROE.—No determinations of organic matter were made, as it was found that the amount was so small that it could not be readily determined in the small sample furnished.

No determinations of Ca were made, the time given for the analytical work not permitting it. It will be seen from the analysis that the water consists of ocean water more or less diluted with fresh water, and that the proportion of fresh water is greater at low tide than at high, except in the case of station B, section 3.

Another feature to be noticed is that the proportion of sulphates in the water analyzed to that in the Atlantic water is greater than that of the chlorides; this point is important.

As both samples of water from section 3, station F, were taken at high water I have designated them as A and B.

○

No. 55

DIAGRAM 8.

TEMPERATURE CURVES

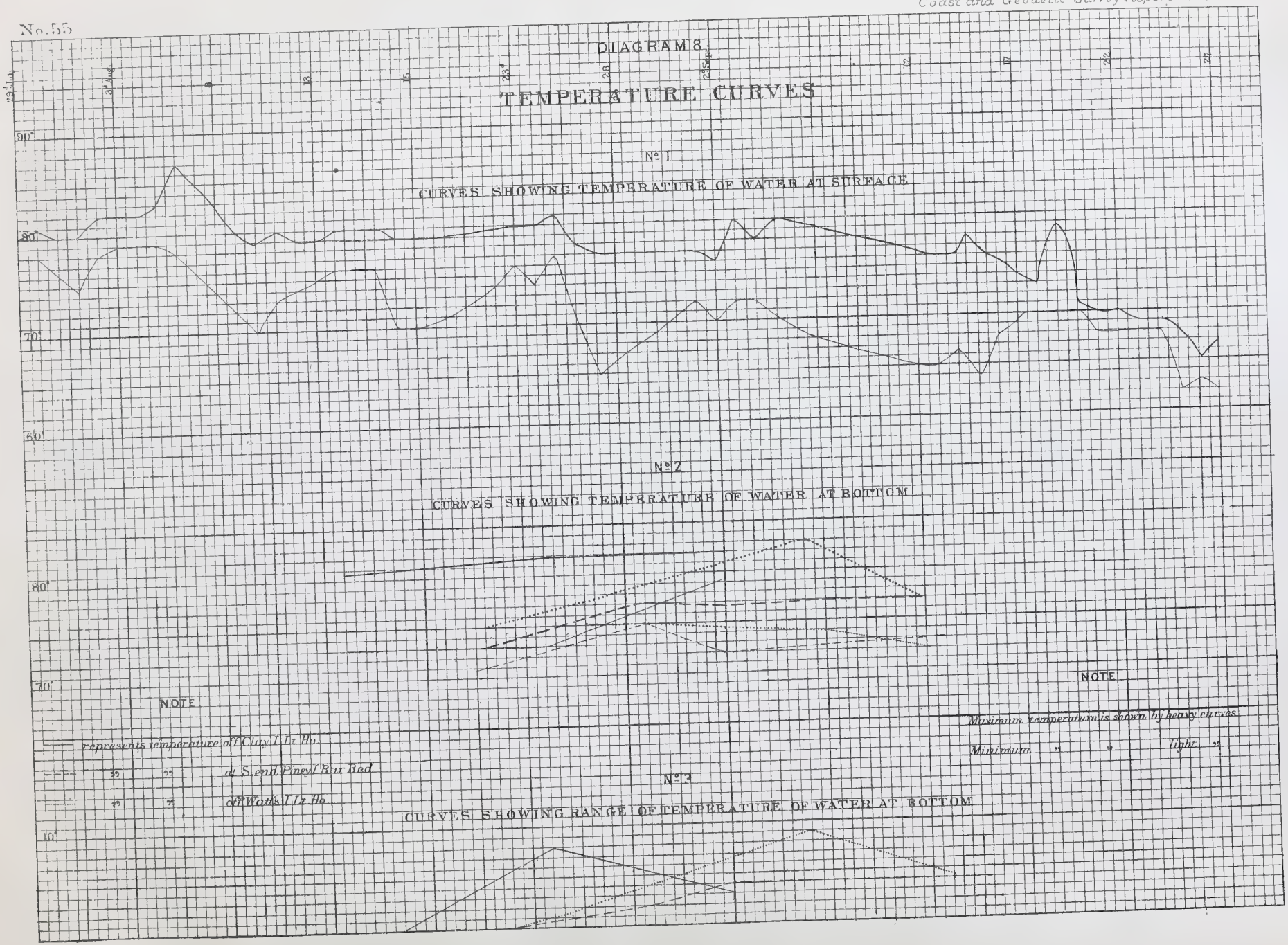

90°
80°
70°
60°
No. 1
CURVES SHOWING TEMPERATURE OF WATER AT SURFACE
No. 2
CURVES SHOWING TEMPERATURE OF WATER AT BOTTOM
No. 3
CURVES SHOWING RANGE OF TEMPERATURE OF WATER AT BOTTOM
NOTE
represents temperature off Clay St Dr Ho
" " at Sixth & Piney Res Boat
" " off Works St Dr Ho
NOTE
Maximum temperature is shown by heavy curves.
Minimum " " light "

DIAGRAM 9.

CURVES SHOWING DIFFERENCE OF DENSITY OF WATER AT BOTTOM

SPRING TIDES

CURVES OF SEC. Nº 1

ACROSS TANGIER SOUND ABOVE HOOPER'S STRAITS

AUG. 4, SEPT. 3 & OCT. 3, 1881

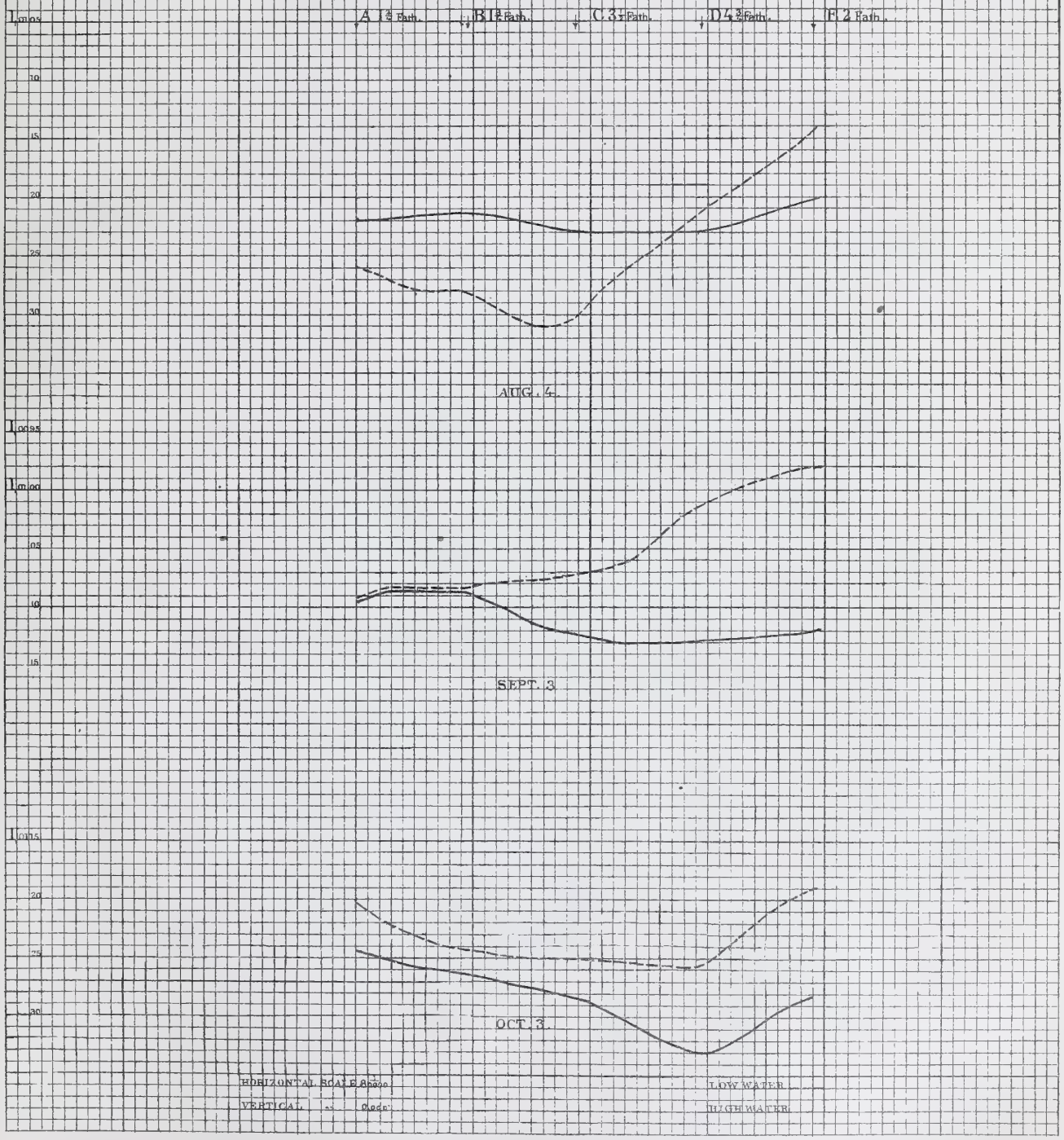


DIAGRAM 10

CURVES SHOWING DIFFERENCE OF DENSITY OF WATER AT BOTTOM

SPRING TIDES

CURVES OF SEC. No. 2.

ACROSS TANGIER SOUND ABOVE KEDGE'S STRAITS

AUG. 2, SEPT. 2 & OCT. 3 1878

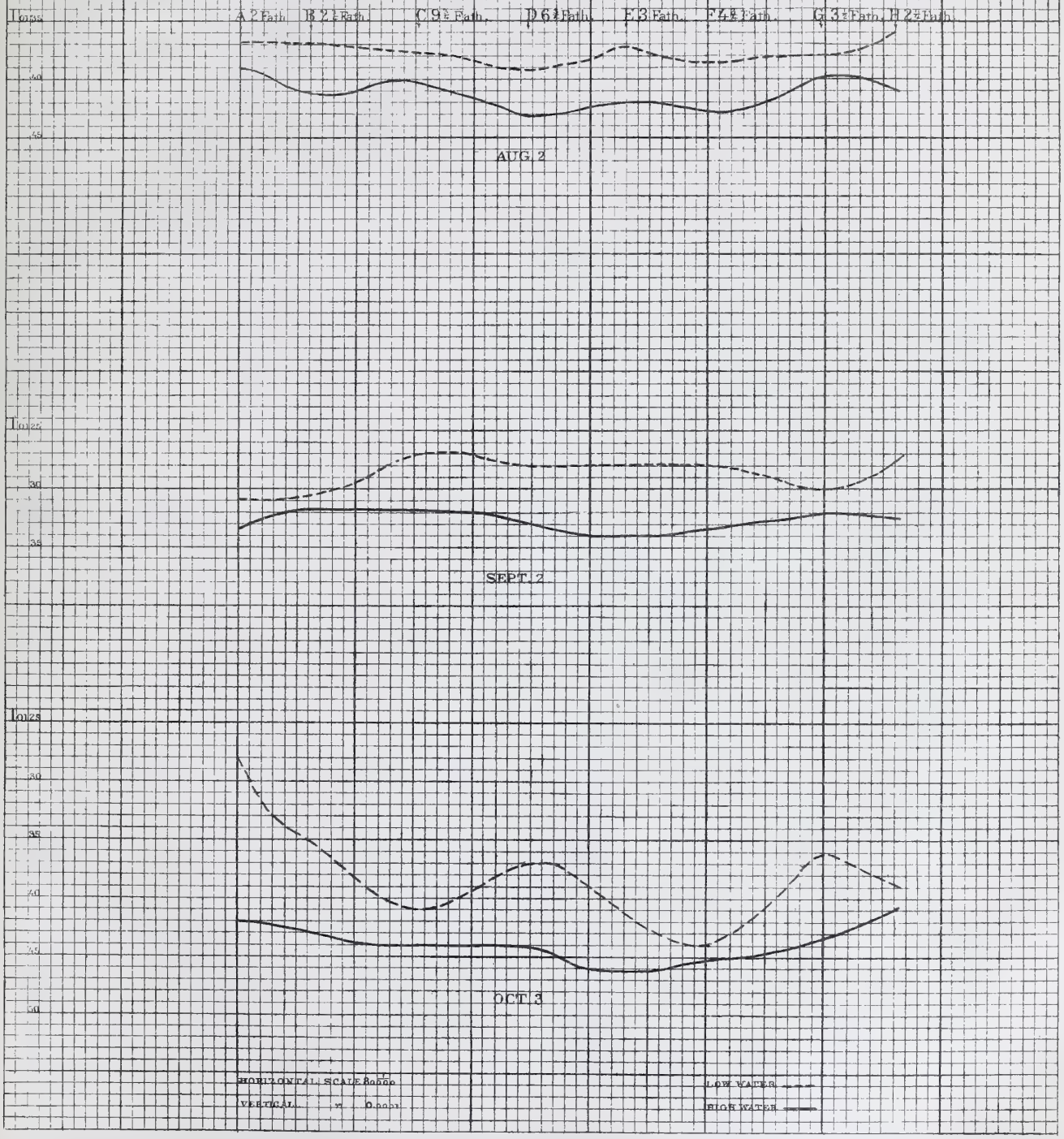


DIAGRAM II

CURVES SHOWING DIFFERENCE OF DENSITY OF WATER AT BOTTOM

SPRING TIDES

CURVES OF SEC. N° 3

ACROSS TANGIER & POCOMOKE SOUNDS BELOW WATT'S L.T.

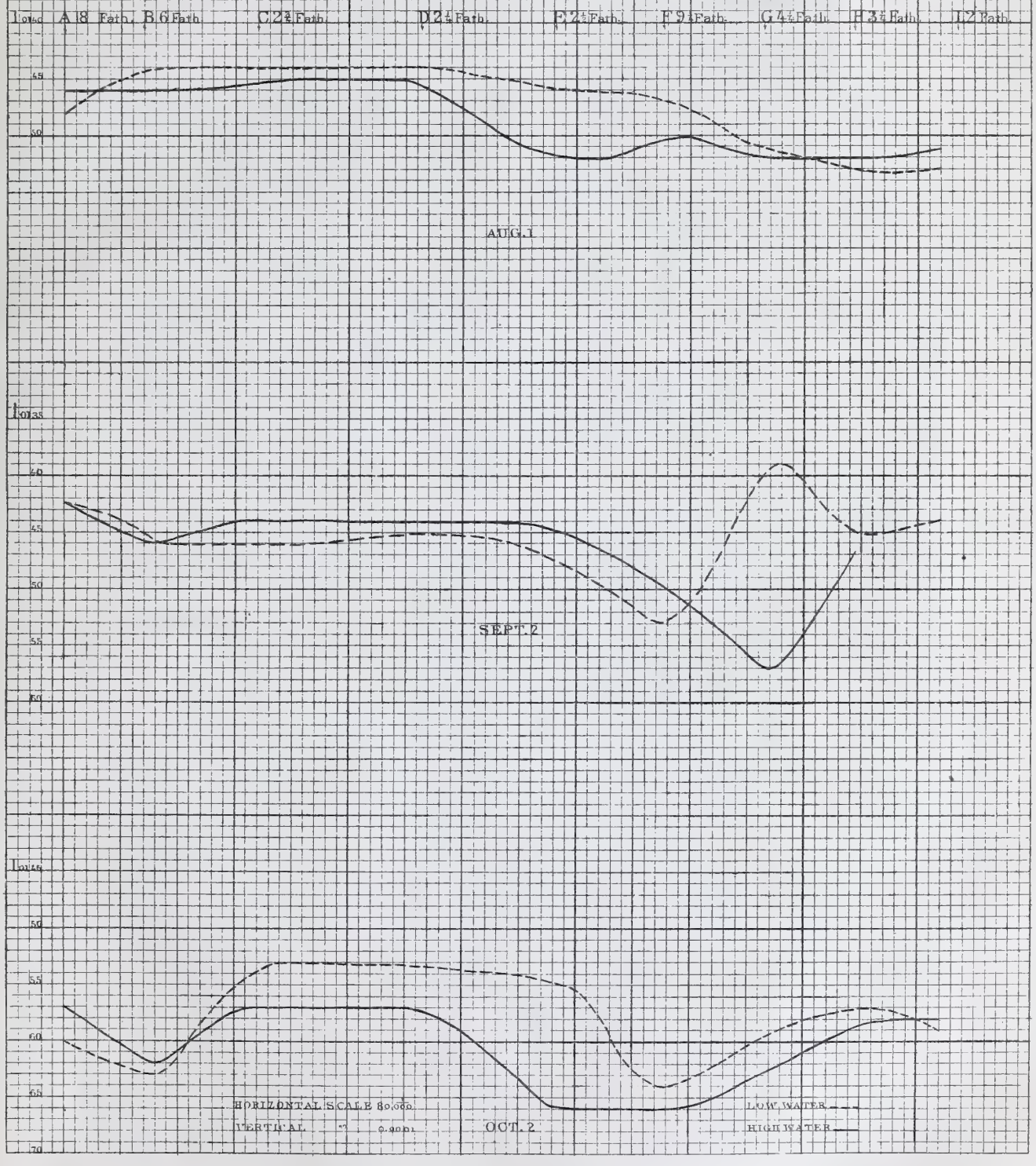


DIAGRAM 12.

CURVES SHOWING DIFFERENCE OF DENSITY OF WATER AT BOTTOM

SPRING TIDES

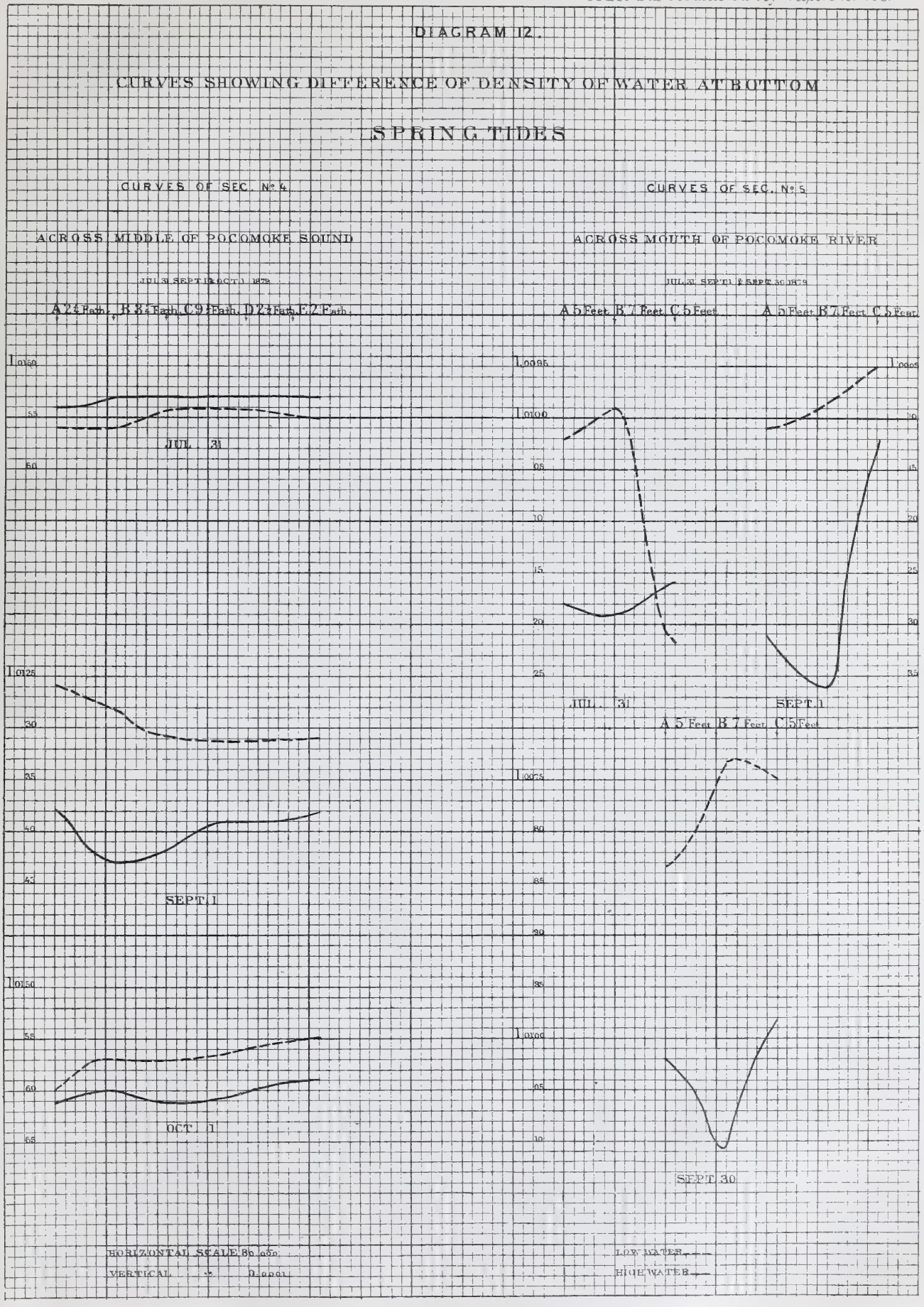


DIAGRAM B.

CURVES SHOWING THE MONTHLY CHANGE OF MEAN DENSITY OF WATER AT BOTTOM

SPRING TIDES

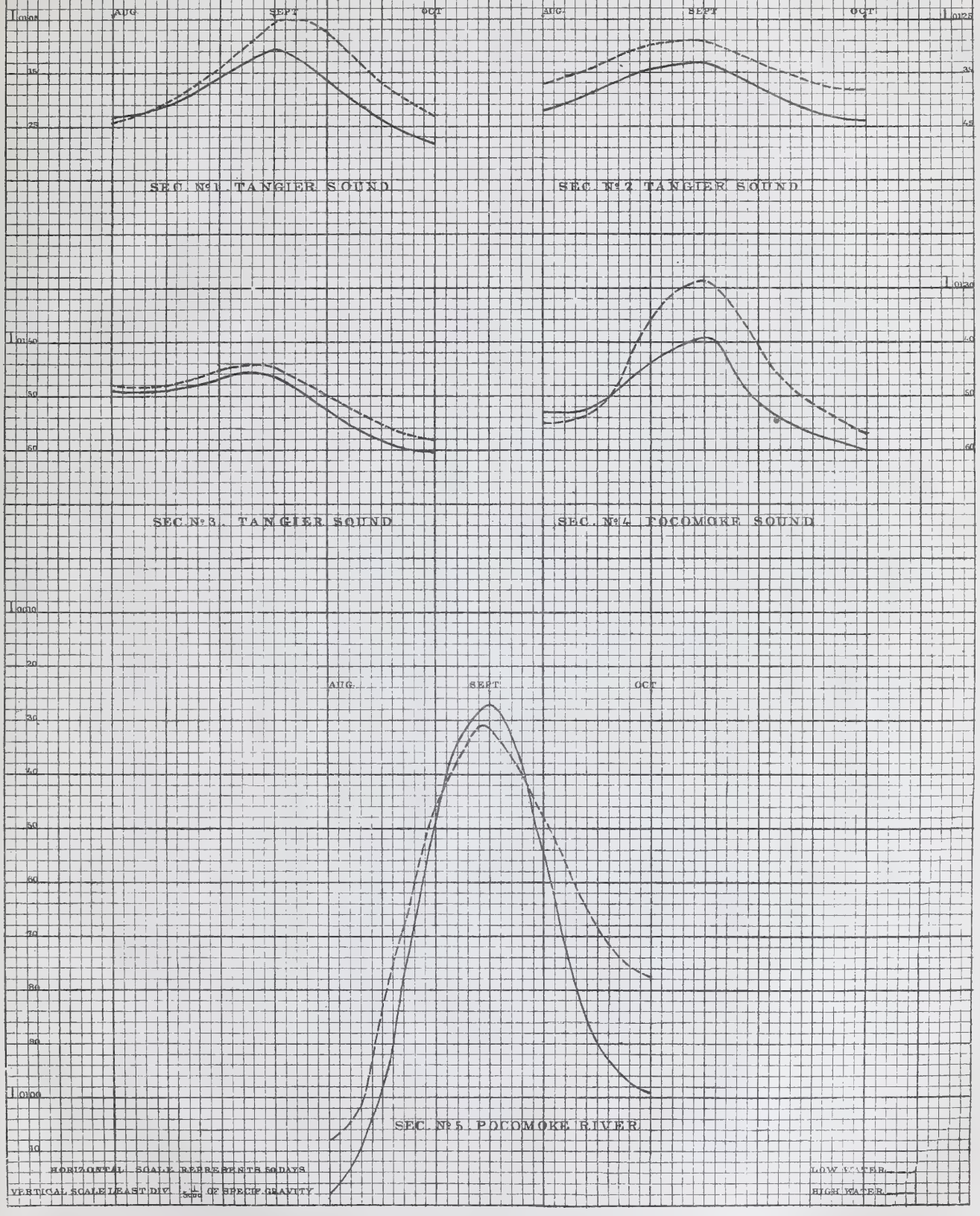


DIAGRAM 14.

CURVES SHOWING THE MONTHLY CHANGE OF MEAN DENSITIES OF WATER AT BOTTOM IN EACH SOUND.

HORIZONTAL SCALE REPRESENTS 30 DAYS

VERTICAL SCALE LEAST DIV. = 1/2000 OF SPECIF. GRAVITY

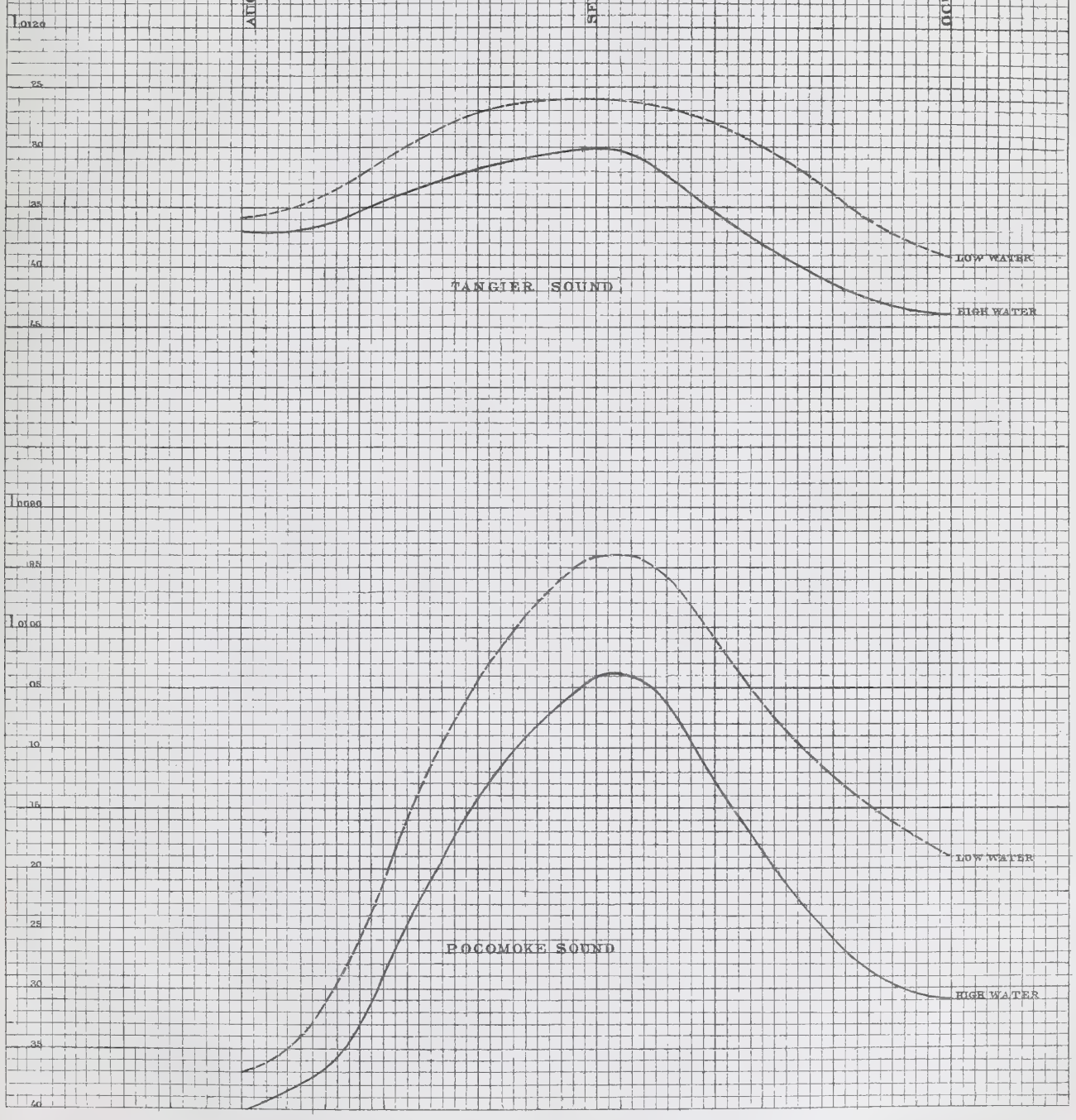


DIAGRAM 15.

CURVES SHOWING DIFFERENCE OF DENSITY OF WATER AT BOTTOM

AT THE HEAD OF AND ENTRANCE TO THE SOUNDS

LONGITUDINAL SECTION IN TANGIER SOUND

LONGITUDINAL SECTION IN POCOMOKE SOUND

AUG.

SEPT.

OCT.

AUG.

SEPT.

OCT.

HORIZONTAL SCALE LEAST DIV. 1 MILE

VERTICAL SCALE LEAST DIV. .0010 DE SPECIFIC GRAVITY

LOW WATER - - - -

HIGH WATER ———

U. S. COAST AND GEODETIC SURVEY

C. P. Patterson, Superintendent

JAMES RIVER

EWPORT NEWS TO DEEP WATER LIGHT

HOWING APPROXIMATE LIMITS

OF OYSTER BEDS

As determined by

FRANCIS WINSLOW, Master U. S. N. Assist.

Commanding Schooner Palinurus

August, 1878

Scale $\frac{1}{50,000}$

Drawn by E. H. Fowler

U. S. COAST AND GEODETIC SURVEY

C. P. Patterson, Superintendent

JAMES RIVER

FROM NEWPORT NEWS TO DEEP WATER LIGHT SHOWING APPROXIMATE LIMITS OF OYSTER BEDS

As determined by

FRANCIS WINSLOW, Master U. S. N. Assist.

Commanding Schooner Palinurus

August, 1878

Scale $\frac{1}{80,000}$

Drawn by E H Fowler

U. S. COAST AND GEODETIC SURVEY
C. P. Patterson, Superintendent

Upper part of
TANGIER SOUND

CHART SHOWING APPROXIMATE POSITION OF OYSTER BEDS

As determined by
FRANCIS WINSLOW, Master U. S. N. Assist.
Commanding Schooner Palinurus
September 1878

Scale 40,000

Nautical Miles

SOUNDINGS

The soundings are expressed in feet ... those that are underlined (5), which are in ... and show the depth at mean low water ... plane of reference

BLOODSWORTH I.

Billy's I.

Adams I.

Holland I.

TANGIER SOUND

SMITH'S ISLAND

Little I.

Hall's Pt.

Hollowa Pt.

Bearing Pt.

Frog Pt.

CLAY I. LIGHT

Section No. 1

Dublin

Rhodes Point

Deal Island

Drum Pt.

Parker's Point

Hard Pt.

MARSHES

Solomon Lump Light

U. S. COAST AND GEODETIC SURVEY
C. P. Patterson Superintendent

Lower part of

TANGIER SOUND AND POCOMOKE SOUND

CHART SHOWING APPROXIMATE POSITION OF OYSTER BEDS

As determined by
FRANCIS WINSLOW, Master U S N, Assist.
Commanding Schooner Palinurus
September 1878
Scale 80,000

SOUNDINGS

The Soundings are expressed in feet except those that are underlined (33) which are in fathoms and show the depth at mean low water, the plane of reference.

Nautical Miles

Yards

SECTION No 1

SECTION No 2

SECTION No 3

SECTION No 4

SECTION No 5

Hazards I.

Fog Harbor

Back Cove

Tangier Sound Light

Tangier I.

Drum Pt.

Big Neck

Horse Hammock

James I. LIGHTS (Fog Bell)

Little Annemessex Harbor

Annemessex River

Shanks Creek

South Pt.

Herring I.

Great Fox I.

Pebbone I.

Reach Hammock

Little Thoroughfare Rock

Goose I.

Queens Reach

Great Thoroughfare Rock

Little Fox I.

Oak Hammock Rock

California Rock

Cod Harbor

Watt's I.

Johnsons Rock

WATT'S ISLAND LIGHT

Parker's Rock

Broad I.

Tobacco I.

Shell Rock

Hill Rock

Quaddlemarsh Flats

Hill I Rock

Apes Hole Creek

Pocomoke River

Pocomoke Sound

Pocomoke Bay

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